

**Mississippi Water Resources Research Institute
Annual Technical Report
FY 2012**

Introduction

The Mississippi Water Resources Research Institute (MWRRI) provides a statewide center of expertise in water and associated land use and serves as a repository of knowledge for use in education, research, planning, and community service.

The MWRRI goals are to serve public and private interests in the conservation, development, and use of water resources; to provide training opportunities in higher education whereby skilled professionals become available to serve government and private sectors alike; to assist planning and regulatory bodies at the local, state, regional, and federal levels; to communicate research findings to potential users in a form that encourages quick comprehension and direct application to water related problems; to assist state agencies in the development and maintenance of a state water management plan; and to facilitate and stimulate planning and management that:

- Deals with water policy issues,
- Supports state water agencies' missions with research on problems encountered and expected,
- Provides water planning and management organizations with tools to increase efficiency and effectiveness.

Research Program Introduction

The Mississippi Water Resources Research Institute (MWRRI) conducts an annual, statewide competitive grants program to solicit research proposals. Proposals are prioritized as they relate to the research priorities established by the MWRRI Advisory Board and by their ability to obtain Letters of Support or External Cost Share from non-federal sources in Mississippi. The MWRRI's External Advisory Board then evaluates all proposals. Based on the most current list of research priorities, these would include: 1) Physical Processes (ex. Climate, Hydrology, Hydraulics and Sediment, Water Quality); this could include a section of a major Mississippi river - construction and validation of a model of the interactions/communications between groundwater and surface water under base flow conditions whereby the model could incorporate water quality and/or quantity; 2) Biotic Processes (ex. Terrestrial, Aquatic); this could include the development of vegetation management plans for drainage canal systems; and 3) Human Systems (ex. Built Environment, Social Sciences, Economics); this could be the evaluation of the economic impacts of consumptive water users in Mississippi as well as assessment of the impacts of various types of Green Infrastructure on water quality. Other issues that could be addressed include: surface and groundwater management, water quality management and water resources development, contaminant transport mechanisms, wetlands and ecosystems, groundwater contamination, as well as other issues addressing coastal and marine issues linking water associates through the state, and institutional needs that include capacity building and graduate student training.

Water quality and other ecosystem services in wetlands managed for waterfowl in Mississippi

Basic Information

Title:	Water quality and other ecosystem services in wetlands managed for waterfowl in Mississippi
Project Number:	2011MS135B
Start Date:	3/1/2011
End Date:	6/30/2013
Funding Source:	104B
Congressional District:	3rd
Research Category:	Water Quality
Focus Category:	Water Quality, Wetlands, Economics
Descriptors:	None
Principal Investigators:	Richard Kaminski, Amy B. Spencer

Publications

1. Quarterly reports 2011-2012 to Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS.
2. Alford, A.B., R.M. Kaminski, L.R. D'Abramo, and J. Avery. 2011. Characteristics of harvestable crayfish populations in managed wetlands of the Lower Mississippi Alluvial Valley. Poster presentation. American Fisheries Society, Seattle, WA. September 4-9, 2011.
3. Alford, A.B. 2011. Crawfish harvest as a wildlife enterprise. Natural Resources Enterprise and LSUAgCenter Paddling and Canoeing and Lease Opportunities for Landowners Workshop. Monroe, LA. September 28, 2011.
4. Alford, A.B., R.M. Kaminski, R. Kroger, L.R. D'Abramo, and J. Avery. 2011. Ecosystem services derived from moist-soil management. Poster presentation. Mississippi Chapter of the Wildlife Society. Louisville, MS, October 4-5, 2011.
5. Alford, A.B., R. Kroger and R.M. Kaminski, 2012, Nutrient characteristics of moist-soil wetlands in agricultural landscapes. Oral presentation, Mississippi Water Resources Conference, Jackson, MS, April 3-4, 2012, online at http://www.wrri.msstate.edu/pdf/2012_wrri_proceedings.pdf, p. 141.
6. Alford, A.B. and R. Kaminski, 2012, Duck hole 'dads' (dat's crawdads), Mossy Oak Gamekeeper: Farming for Wildlife, Spring 2012.
7. Final Technical Report, 2013, Water quality and other ecosystem services from wetlands managed for waterfowl in Mississippi, 17 pgs.
8. Alford, A.B., R.M. Kaminski, S. Grado, L. D'Abramo and J. Avery, 2013, Crayfish harvesting: alternative opportunities for landowners practicing moist-soil wetland management, Ecology and Conservation of North American Waterfowl, Memphis, TN, January 2013, Oral Presentation.
9. Alford, A.B., R. Kroger and R.M. Kaminski, 2013, Water quality from moist-soil wetlands in agriculture landscapes: a comparative approach, Ecology and Conservation of North American Waterfowl, Memphis, TN, January 2013, Poster Session.

Mississippi Water Resources Research Institute (MWRRI)

Quarterly Report – (From) 03/01/12 – (To) 03/31/13

Reports due: 1st (March 31); 2nd (June 30); 3rd (Sept. 30); 4th (Dec. 31)

Note: Please complete form in 11 point font and do not exceed two pages. You may reference and append additional material to the report.

SECTION I: Contact Information

Project Title: Water quality and other ecosystem services in wetlands managed for waterfowl in Mississippi

Principal Investigator: Amy B. Alford and Richard M. Kaminski, Ph.D.

Institution: Department of Wildlife, Fisheries, and Aquaculture, Mississippi State University

Address: 775 Stone Blvd., Mississippi State, MS 39762

Phone/Fax: 662-325-2623

E-Mail: rkaminski@cfr.msstate.edu, aspencer@cfr.msstate.edu

SECTION II: Programmatic Information

Approximate expenditures during reporting period:

Federal: \$4,037.39, Non-Federal (MWRRI): \$12,269.05, Non-Federal (Dept.): \$9,937.00,
In-Kind: \$6,000.00, Total Cost Share: \$28,206.05

Equipment (and cost) purchased during reporting period:

Progress Report (Where are you at in your work plan):

We completed all field aspects of this study in May 2012. All data loggers have been removed from study sites and we are currently analyzing the data and creating hydrographs. Estimates of nutrient and sediment concentrations in runoff from agricultural fields and wetlands for 2012 have been analyzed for differences using a repeated measures design. Preliminary results (Table) suggest that in 2011 and 2012, total suspended solids differed significantly between the two habitat types and that TSS concentrations in runoff samples from agricultural sites were more than 5 times greater than those recorded in wetland runoff. Whereas TP and DIP differed significantly over time in 2011 and 2012, the concentrations of these fractions of phosphorus differed among habitats only in 2012. Although significantly less than the average concentration in agriculture fields, the average concentration of TP in wetland runoff was greater than recommended for Region X by the Environmental Protection Agency (0.128 mg/l). Concentrations of NO₃ differed between habitats in both years but also varied across time in 2011. Concentrations of NH₃ did not differ between habitats or over time.

These results suggest that because phosphorus can be found bound to sediments, managing for wetlands in agricultural landscapes may reduce total phosphorus loads to receiving waterbodies through sediment retention. Additionally, estimates of phosphorus in wetland runoff exceed current EPA recommendations; estimates of nutrient loading to the Lower Mississippi River basin contributed by wetland runoff likely need to be adjusted. Finally, because wetlands and agriculture fields exhibited no difference in NH₃ concentrations in runoff in this study, it cannot be assumed that moist-soil wetlands provide any additional benefit to ammonia loading in the Lower Mississippi River Basin. However, these analyses only represent the period when moist-soil wetlands are flooded in the winter and do not provide year-long estimates. We are currently adjust concentrations for runoff volume using appropriate flow equations and will present loads (kg/ha) in the final agency report.

Table. Mean (SE) concentrations (mg/l) of nutrients and sediments in agriculture and wetland runoff samples for November-May 2011 and 2012. Treatment means are represented as

unadjusted for temporal effects models. * = Significant ($p < 0.05$) across time, ** = significant between habitats, *** = significant across time and between habitats.

	Agriculture	Wetland
	<u>2011</u>	
TP*	0.45(0.06)	0.32(0.03)
DIP*	0.10(0.01)	0.11(0.02)
NO ₃ ***	2.06(0.96)	0.23(0.03)
NH ₃	0.23(0.11)	0.12(0.04)
TSS**	190.6(37.8)	34.6(8.62)
	<u>2012</u>	
TP***	2.02(0.32)	0.92(0.13)
DIP***	0.33(0.50)	0.29(0.04)
NO ₃ **	1.3(0.46)	0.26(0.02)
NH ₃	0.18(0.06)	0.09(0.01)
TSS**	277.6(58.3)	16.6(0.01)

We completed all field aspects of this study in May 2012. All data loggers have been removed from study sites and hydrographs have been created from downloaded data.

We calculated flow adjusted loads of nutrients and sediments exported from moist-soil wetlands during the impounded period (December-March) 2010-2012 (Table 1). We sampled four wetlands in 2010-2011. We sampled the same wetlands in 2011-2012 in addition to a fifth wetland. We were able to estimate loads from 30 storm events in the first winter and 32 storm events in the second year. Average storm loads for nutrients and sediments in 2010-2011 were greater than those estimated in 2011-2012. Although the number of storm events monitored was similar between years, the differences in loadings likely resulted because average volume of water exported during each storm event in the first year was greater than those observed in the second year. Average wetland runoff volume during storm events in 2010-2012 was $20 \cdot 10^6$ L whereas runoff volume in 2011-2012 was only $8 \cdot 10^6$ L.

Current assumed loads of total inorganic phosphorous and nitrogen delivered to the Gulf of Mexico from wetlands in the Mississippi Alluvial Valley are 1 kg/ha; we estimate wetlands are delivering slightly more orthophosphate to the Gulf of Mexico than previously assumed.

Table 1. Average loads (kg/ha) of nutrients and sediments exported from moist-soil wetlands during monitored storm events in December-March 2010-2012. Values in parentheses represent standard error.

Year	Water Quality Parameter				
	TP	SRP	NO ₃	NH ₃	TSS
2010	1.18(0.44)	0.52(0.22)	0.12(0.04)	0.49(0.32)	40(16)
2011	0.64(0.28)	0.22(0.08)	0.12(0.03)	0.04(0.01)	5.4(1.4)

We submitted the final technical report for this project in October. We were granted a no-cost extension to allow Amy to present the project results at the Ecology and Conservation of North American Waterfowl symposium in Memphis, TN January 27-31, 2013. Amy will be presenting a poster presentation related to the water quality component of this research and an oral presentation related to the economic evaluation of crayfish harvests in a special session

covering topics related to benefits that landowners can realize from wetland management and conservation.

Amy presented project results at the Ecology and Conservation of North American Waterfowl symposium in Memphis, TN January 27-31, 2013. Amy presented a poster presentation related to the water quality component of this research and an oral presentation related to the economic evaluation of crayfish harvests in a special session covering topics related to benefits that landowners can realize from wetland management and conservation.

Problems Encountered:

No problems to report.

Publications/Presentations (Please provide a citation and if possible a .PDF of the publication or PowerPoint):

Alford, A.B. R. Kroger, and R.M. Kaminski. 2012. Nutrient characteristics of moist-soil wetlands in agricultural landscapes. Oral presentation. Mississippi Water Resources Conference. April 3-4, 2012. Jackson, MS.

Alford, A.B., R.M. Kaminski, S. Grado, L. D'Abramo, and J. Avery. 2013. Crayfish harvesting: alternative opportunities for landowners practicing moist-soil wetland management. Ecology and Conservation of North American Waterfowl, Memphis, TN. January 2013. Oral Presentation.

Alford, A.B., R. Kroger, and R.M. Kaminski. 2013. Water quality from moist-soil wetlands in agriculture landscapes: a comparative approach. Ecology and Conservation of North American Waterfowl, Memphis, TN. January 2013. Poster Presentation.

Student Training (list all students working on or funded by this project)

Name	Level	Major
Kelsey Brock	B.A.	Speech

Next Quarter Plans:

Amy Alford, the doctoral candidate on the project will be completing data analysis and will begin writing the dissertation.

Amy Alford, the doctoral candidate on the project has begun writing the dissertation and will present the final report in October 2012.

Amy Alford, the doctoral candidate on the project will be completing the dissertation and presenting the final summary of the project at the 2013 Mississippi Water Resources Conference.

Amy Alford, the doctoral candidate on the project will be completing the dissertation and presenting the final summary of the project at the 2013 Mississippi Water Resources Conference.

Comparisons of Indigenous and Selected Bacterial Degrading Pentachlorophenol (PCP) Consortiums for Remediation of PCP Contaminated Groundwater

Basic Information

Title:	Comparisons of Indigenous and Selected Bacterial Degrading Pentachlorophenol (PCP) Consortiums for Remediation of PCP Contaminated Groundwater
Project Number:	2011MS136B
Start Date:	3/1/2011
End Date:	12/15/2012
Funding Source:	104B
Congressional District:	3rd
Research Category:	Water Quality
Focus Category:	Water Quality, Toxic Substances, Groundwater
Descriptors:	None
Principal Investigators:	M Lynn Prewitt, Hamid Borazjani, Ken O Willeford

Publications

1. Quarterly reports 2011-2012 to Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS.
2. Joshi, V., M.L. Prewitt, H. Borazjani, D.P. Ma, and K. Willeford. Comparison of Indigenous and Selected Pentachlorophenol (PCP) Degrading Bacterial Consortiums for Remediation of PCP Contaminated Groundwater. Poster presented at Mississippi Water Resources Conference, April 3-4, 2012, Jackson, MS, Proceedings pgs. 22-29.
http://www.wrri.msstate.edu/pdf/2012_wrri_proceedings.pdf
3. Lee, M., S.P. Mun, H. Borazjani, and M.L. Prewitt. Formaldehyde released in leachate from medium density fiberboard (MDF) buried in a simulated landfill. Oral presentation at Mississippi Water Resources Conference, April 3-4, 2012, Jackson, MS, Proceedings pgs. 30-36.
http://www.wrri.msstate.edu/pdf/2012_wrri_proceedings.pdf

**Comparisons of Indigenous and Selected Bacterial Degrading Pentachlorophenol
(PCP) Consortia for Remediation of PCP Contaminated Groundwater**

Final Report

**Start Date: 07/01/2011
End Date: 12/31/2012**

**Dr. M. Lynn Prewitt
Dr. Hamid Borazjani
Dr. Kenneth Willeford**

Submitted 03/26/2013

Account Number:

**Mississippi State University
P.O. Box 9820
Mississippi State MS, 39762**

Statement of Critical Regional Water Problems

Groundwater is a valuable commodity not only in Mississippi and the region but the United States and worldwide because it impacts the health and diversity of all living organisms that comprise our ecosystems. Groundwater provides more than 90% of the drinking water supply in Mississippi. Approximately 2.6 billion gallons of water are pumped from aquifers in Mississippi each day of which 65% is used for irrigation, 15% for aquaculture and 11% for public supply. There are 1535 public water systems that use 3300 wells from 16 major aquifers and many minor aquifers throughout Mississippi that provide needed water. Therefore Mississippi and the world need to protect its groundwater quality from contamination.

Sources of groundwater contamination in Mississippi include: leaking underground storage tanks (USTs) that hold petroleum-based products and have faulty septic systems; localized brine (saltwater) contamination of shallow aquifers, agriculture practices and improper handling and storage of hazardous wastes at commercial and industrial facilities. Groundwater quality and cleanup of contaminated sites is overseen nationally by the Environmental Protection Agency (EPA) and in Mississippi by the Groundwater Assessment and Remediation Division (GARD) within the Department of Environmental Quality's Office of Pollution Control. Mississippi has four sites of groundwater contamination by wood preservatives that are listed on the EPA's Superfund National Priority List of hazardous waste sites. These sites are located in Flowood, Hattiesburg, Louisville and Picayune where pentachlorophenol (PCP) and creosote were used to treat utility poles and crossties. PCP and creosote are characterized as probable human carcinogens and their cleanup in contaminated groundwater at these sites in Mississippi is estimated to cost between \$70 and \$75 million.

Statement of Results, Benefits and/or Information

Results from this research are expected to reveal which of 3 consortiums of bioaugmented PCP degrading bacteria will increase PCP degradation in contaminated groundwater. The information that will be gained from this research should lead to customizing remediation methods based on the indigenous microbial community at a contaminated site. Not only could bacterial consortiums be used for PCP degradation, they could also be used to address other water quality issues such as high Biological Oxygen Demand (BOD) that impacts wastewater discharge from industries in Mississippi and nationwide such as the pulp and paper mills, oil spills in the Gulf Coast and excess nitrogen in agriculture runoff.

Nature, Scope and Objective of Research

PCP is a five chlorine containing aromatic phenolic compound that makes it not only a very effective wood preservative and herbicide but a persistent contaminant when it is placed in the environment (Cole et al. 1996). PCP works by disruptive oxidative phosphorylation of living cells. Chlorinated dioxins, extremely toxic compounds, are often present with PCP as a result of the manufacturing process increasing the urgency in remediating this contaminant. PCP has also been used for

over 60 years in many industrial settings including tanneries, distilleries, paint manufacturing and pulp and paper mills (Chandra et al 2006).

Because PCP is highly toxic and very recalcitrant it has been classified as a priority pollutant by the Environmental Protection Agency (EPA). As a result of the wood treating process, wood treating facilities have generated millions of gallons of PCP contaminated groundwater. Groundwater contamination by PCP has resulted because of poor disposal and usage practices and has become a major health and environmental concern (Langwaldt 1998).

One of the most promising methods for remediation of PCP contaminated groundwater is biosparging. Biosparging utilizes the indigenous microorganisms found in contaminated groundwater to biodegrade organic pollutants such as PCP. Clean air is injected into the contaminated zones increasing the oxygen concentration in the groundwater thereby enhancing aerobic biodegradation of the pollutant. Nutrients such as nitrogen, phosphorus and potassium may be added to also stimulate biodegradation. This technology can reduce the cost of remediation of contaminated sites and control the migration of contaminants into the subsurface.

Materials and Methods

Approximately 19 liters of PCP contaminated groundwater was collected from a monitoring well located nearest a PCP contaminated lagoon and outside of the air sparging impact zone. This research was conducted with four treatments and three replicates within each treatment. The four treatments were: groundwater + nutrients (Treatment 1), groundwater + nutrients + *Sphingobium chlorophenolicum* (Treatment 2), groundwater + nutrients + *Burkholderia cepacia* (Treatment 3), and groundwater + nutrients + *S. chlorophenolicum* + *B. cepacia* (Treatment 4). Each treatment contained 750 ml groundwater plus 2 teaspoons of Miracle Gro™. Bottles were capped with a plastic cap containing a 3 mm hole used for weekly air sparging. Treatment bottles were daily shaken manually for one minute. Treatments 3 and 4 were kept in a locked cooler at room temperature because Bio-Safety level 2 (BSL2) regulations are required for *B. cepacia*. A two hundred fifty milliliter groundwater sample was analyzed on day 0, 36 and 72 for pH, bacterial enumerations, PCP concentration (EPA method 3510C), and mRNA gene expression. Bacterial identification using DNA based techniques was performed on Day 0. A complete description of the experimental methods is found in Joshi et al. 2012.

Results and Discussion

The pH of the groundwater was initially acidic (3.8) but increased to 8.4 by the end of the study. Optimal growth for most microbial communities in groundwater is at neutral pH. The pH and PCP tolerant bacteria correlated strongly positive indicating that as the pH approached the neutral range the number of PCP tolerant bacteria increased (Figure 1).

The most frequently identified bacteria in the PCP contaminated groundwater were: *Burkholderia* sp. (35%), *Ralstonia eutropha* (20%) *Cupriavidus* sp (18%), *Bacillus cereus* sp (18%), *S. chlorophenolicum* (6%) and *Pseudomonas* sp (Figure 2). *Burkholderia* sp., *S. chlorophenolicum* sp, *Bacillus cereus* and *Pseudomonas* sp have

been reported to degrade PCP in groundwater (He et al. 2008, Karn et al 2010 (a, b), Louie et al. 2002, Sanchez and Gonzalez 2007, Xun and Gisi 2003).

The initial concentration of PCP in the groundwater was 0.49 ppm and was higher than the maximum containment level of 1 ppb for drinking water set by the EPA. There was no significant reduction in PCP in treatment 1 which contained no added bacteria (Figure 3). However, the single bacterium amended treatments did show PCP reductions of 32% and 49% but no significant reduction was observed in the two bacteria amended treatment 4. The lack of PCP reduction in treatment 4 may have been due to antagonistic effects. Similar results have been reported in other studies involving other environmental contaminants (Slatter and Lovatt 1984, Wijngaard et al. 1993). A negative correlation ($r = -0.62$) resulted between the average PCP concentration and the average PCP tolerant bacteria in all treatments indicating that as the number of PCP tolerant bacteria increased the average PCP concentration decreased in all treatments.

mRNA gene expression analyses were performed in order to determine which members of the bacterial community were expressing genes for the production of enzymes that would degrade the PCP. Gene specific primers were developed for the dominant PCP degrading bacteria, *Burkholderia cepacia*, and a minor PCP degrading bacteria, *Sphingobium chlorophenolicum*. Treatment 1 (groundwater plus nutrients) was used as the control treatment and its gene expression was set to 1 for gene both the *S. chlorophenolicum* and *B. cepacia* PCP degrading genes. The relative expression of the *B. cepacia* gene in Treatment 2 (nutrients plus *S. chlorophenolicum*) on day 0 was 2X the expression in the control treatment, increased to approximately 8X the control on day 36 and decreased to approximately 5X the control on day 72 (Figure 4). In Treatment 3 (nutrients plus *B. cepacia*) on day 0 the relative gene expression of the *B. cepacia* PCP degrading gene was 2X the control, and like in Treatment 2 increased to approximately 8X at day 36 but continued to increase by 11X the control on day 72. The relative gene expression of the *B. cepacia* gene in the mixed culture Treatment 4 on day 0 was approximately 4X that in the control treatment, did not change at day 32 and increased only slightly by the end of the study. Overall, a strong negative correlation ($r = -0.8139$) between the *B. cepacia* PCP degrading gene expression and the PCP concentration indicated that as the gene expression increased the PCP concentration decreased (Figure 5). The lack of substantial increase in gene expression in treatment 4 over the study may support the concept that an antagonistic effect results from *S. chlorophenolicum* toward *B. cepacia* when these cultures are inoculated together in PCP contaminated groundwater.

The relative gene expression by the minor PCP degrading bacteria, *S. chlorophenolicum* on day 0 in Treatment 2 (nutrients plus *S. chlorophenolicum*) was less than the expression in the control treatment but increased to 4X the control at day 32 and 7X on day 72 (Figure 6). In Treatment 3 (nutrients plus *B. cepacia*) the relative gene expression of the *S. chlorophenolicum* PCP degrading gene was also less than in the control but increased to approximately the same as the control on day 36 and day 72. The relative *S. chlorophenolicum* gene expression in the *S. chlorophenolicum* and *B. cepacia* mixed treatment was also less than the control on day 0, increased to 7X the control on day 36 but decreased to 5X the control on day 72. The *S. chlorophenolicum* gene was not as affected by the presence of the *B. cepacia* as was seen by the B.

cepacia gene when mixed with *S. chlorophenolicum*. A weak negative correlation ($r = -0.4105$) resulted between the PCP degrading gene expression of *S. chlorophenolicum* and the PCP concentration (Figure 7).

In summary, the results of this study indicate that identification of the indigenous groundwater bacterial community before beginning treatment at a contaminated site would help to select known PCP degrading bacteria to be added to the groundwater in order to increase remediation of the contaminant. It is not only important to know the members of the indigenous community but also to know the members who are actively producing enzymes (gene expression) to degrade the contaminant. We conclude from this study that adding known PCP degrading bacteria (identified in the PCP contaminated groundwater) to an indigenous community along with the addition of nutrients and air sparging will increase the degradation of PCP and enhance the bioremediation effort.

Further studies, student training, information transfer, or source of funding

Further studies should include determining the activity of the PCP degrading enzymes from *Burkholderia cepacia*. In this study we assumed that because the genes for the PCP degrading enzymes were expressed, the corresponding enzymes were produced. However this needs to be verified. It is also possible that if these enzymes were produced, their activity was not sufficient to have caused the reduction in PCP and another enzyme was responsible for this reduction. Therefore the enzyme activity should be determined. Lastly, laboratory results do not always translate into field results and further studies should include a field study.

This project provided funding and training for one master student, Vaibhav Joshi, who has written and defended his thesis research, has completed the requirements for a master's degree and will graduate in May 2013. Also working with Mr. Joshi was Min Lee, another graduate student. Mr. Joshi presented the results from this research project to three professional conferences: Water Resources Research Institute, Forest Products Society and Environmental Science and Technology. Mr. Joshi will also present these results at the American Wood Preserver's Conference in Hawaii next month. One non-referred paper has been published (Proceedings of the Mississippi Water Resource Conference), one has been submitted to a referred journal for publication (The Journal of General and Applied Microbiology) and one more is in final stages of preparation for submission to another referred journal (Journal of Applied Microbiology).

This project was also supported in part by the Department of Forest Products. Results from this research should provide background information for seeking funding from industries associated with wood preservation or other environmental contaminants and the EPA.

References

- Chandra R., Ghosh A., Jain R. K. and Singh S. 2006. Isolation and characterization of two potential pentachlorophenol degrading aerobic bacteria from pulp paper effluent sludge. *Journal of General Applied Microbiology*.52: 125–130.
- He L., Guangwei L., Xiufen L. and Chen J. 2008.Molecular characterization of bacterial community in aerobic granular sludge stressed by pentachlorophenol..*Journal of Environmental Sciences*. 20: 1243–1249.
- Joshi V., Prewitt M. L., Borazjani H., Ma D. P. 2012. Comparison of Indigenous and Selected Pentachlorophenol (PCP) Degrading Bacterial Consortia for Remediation of PCP Contaminated Groundwater. Mississippi Water Resources conference, Jackson, USA. April 3-4, 2012 (Conference proceedings).
- Karn S. K., Chakrabarty S. K. and Reddy M. S. 2010 (a). Characterization of pentachlorophenol degrading *Bacillus* strains from secondary pulp-and-paper-industry sludge. *International Biodeterioration and Biodegradation*. 64: 609-613.
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- Wijngaard A. J. V., Kleij R. G. V., Doornweerd R. E. and Janssen D. B. Influence of organic nutrients and co-cultures on the competitive behavior of 1,2-dichloroethane-degrading bacteria. 1993. *Applied and Environmental Microbiology*. 59: 3400-3405.
- Xun L. and Gisi M. R. 2003. Characterization of chlorophenol-4-monooxygenase (tftD) and NADH: flavin adenine dinucleotide oxidoreductase (tftC) of *Burkholderia cepacia* AC 1100. *Journal of Bacteriology*. 185: 2786-2792.

Figures

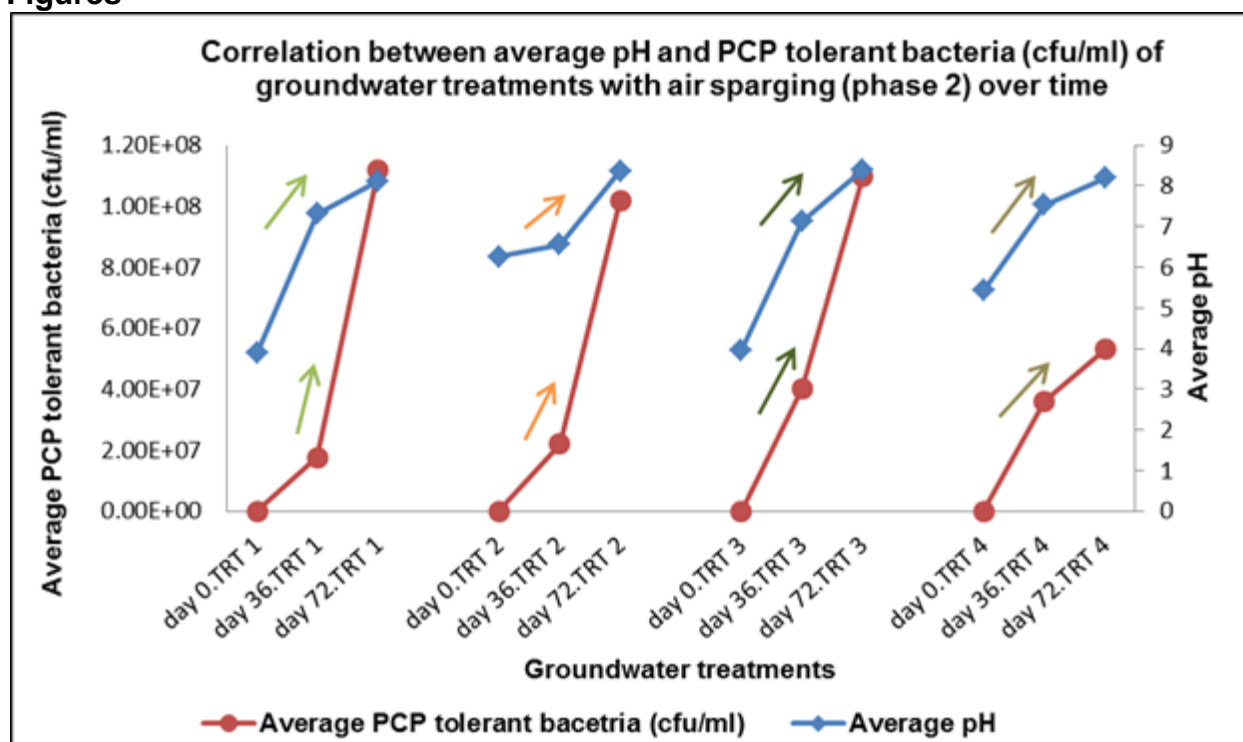


Figure 1 Correlation between average pH and PCP tolerant bacteria (cfu/ml) of groundwater treatments with air sparging (phase 2) over time. Treatments: TRT 1= with Miracle Gro™, TRT 2= Miracle Gro™ + *S. chlorophenolicum*, TRT 3= Miracle Gro™ + *B. cepacia* and TRT 4= Miracle Gro™ + *S. chlorophenolicum* + *B. cepacia*. There were three replicates per treatment. Correlation coefficient (r) values: TRT 1= 0.7521, TRT 2= 0.9970, TRT 3= 0.9219 and TRT 4= 0.9959. Average Correlation coefficient (r) value of all treatments over time= 0.9176.

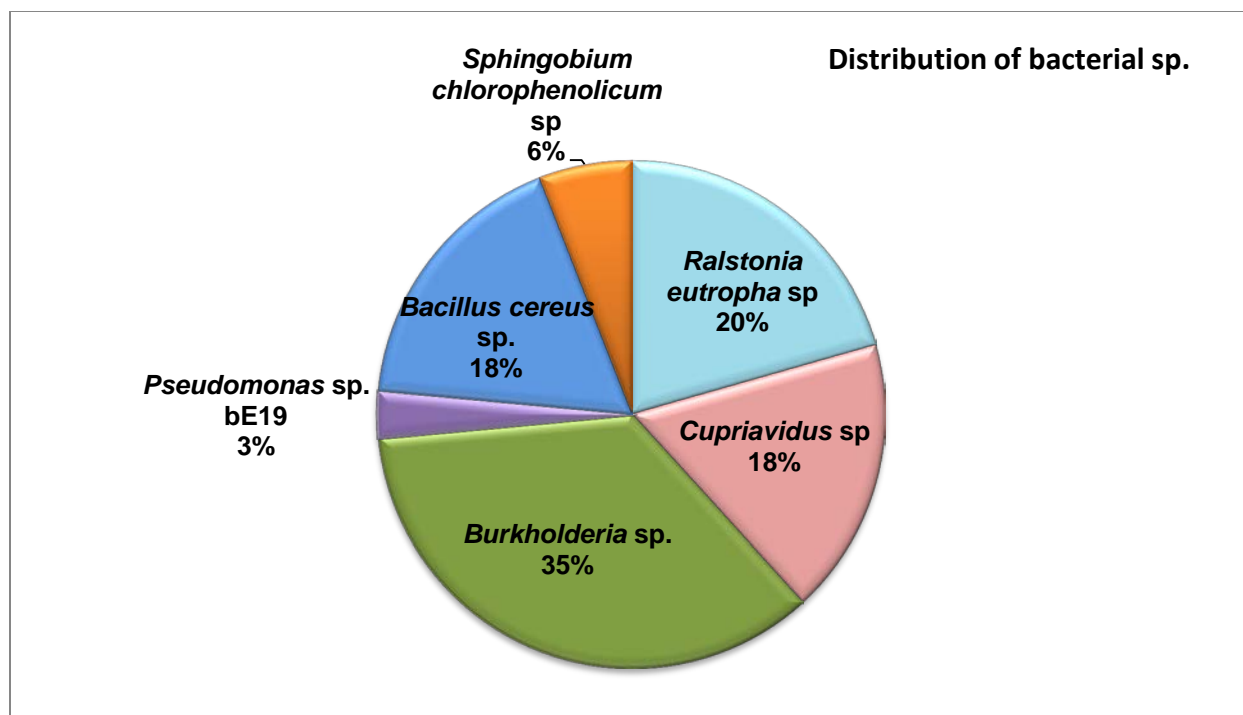


Figure 2 Composition of PCP tolerant bacterial species in PCP contaminated groundwater.

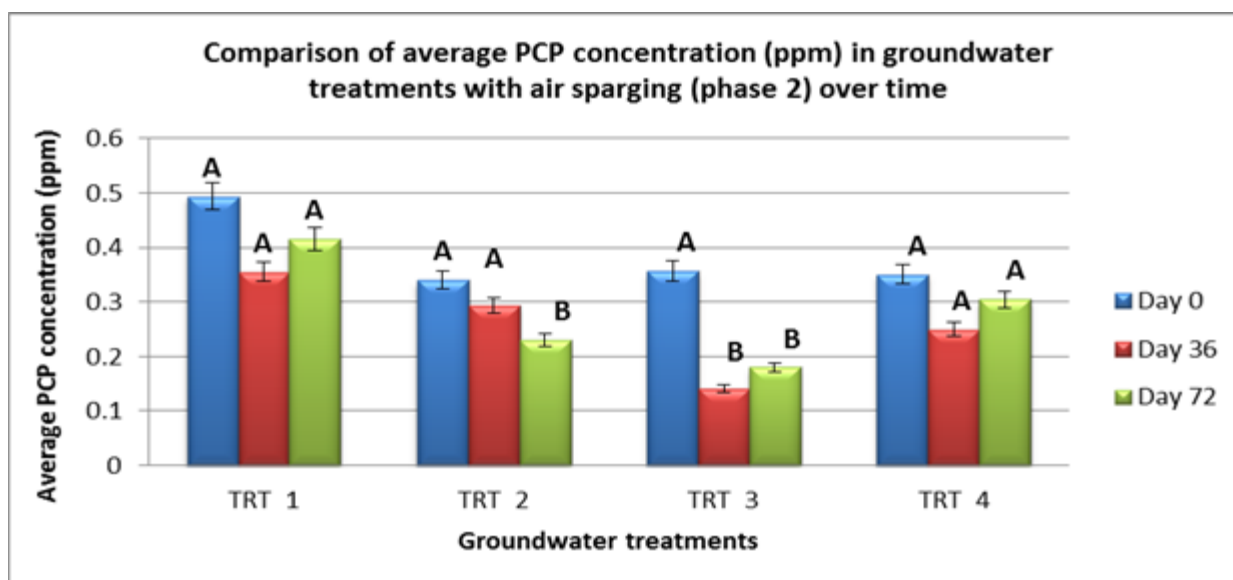


Figure 3 Comparison of average PCP concentration (ppm) in groundwater treatments with air sparging (phase 2) over sampling times day 0, 36 and 72. Treatments: TRT 1= with Miracle Gro™, TRT 2= Miracle Gro™ + *S. chlorophenolicum*, TRT 3= Miracle Gro™ + *B. cepacia* and TRT 4= Miracle Gro™ + *S. chlorophenolicum* + *B. cepacia*. There were three replicates per treatment. Letters A and B indicate statistically different average PCP concentration values of treatments over time. Statistical values: $\alpha = 0.05$ for all treatments. TRT 1: F value= 3.9, F critical= 4.3 and P value= 0.07; TRT 2: F value= 19.6, F critical= 4.3 and P value= 0.01; TRT 3: F value= 294, F critical= 4.3, P value= 0.0001, TRT 4: F value= 3.4, F critical= 4.3, P value= 0.1.

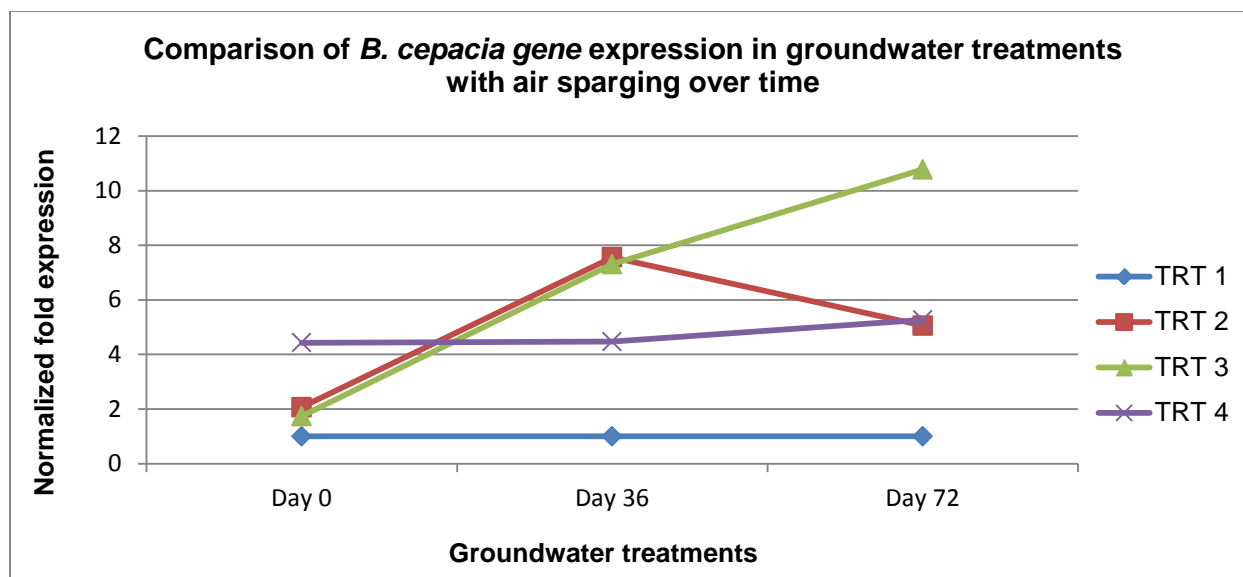


Figure 4. Comparison of *B. cepacia* gene expression in groundwater treatments with air sparging (phase 2) over sampling times day 0, 36 and 72. Treatments: TRT 1 = with Miracle Gro™, TRT 2 = Miracle Gro™ + *S. chlorophenolicum*, TRT 3 = Miracle Gro™ + *B. cepacia* and TRT 4 = Miracle Gro™ + *S. chlorophenolicum* + *B. cepacia*. There were three replicates per treatment.

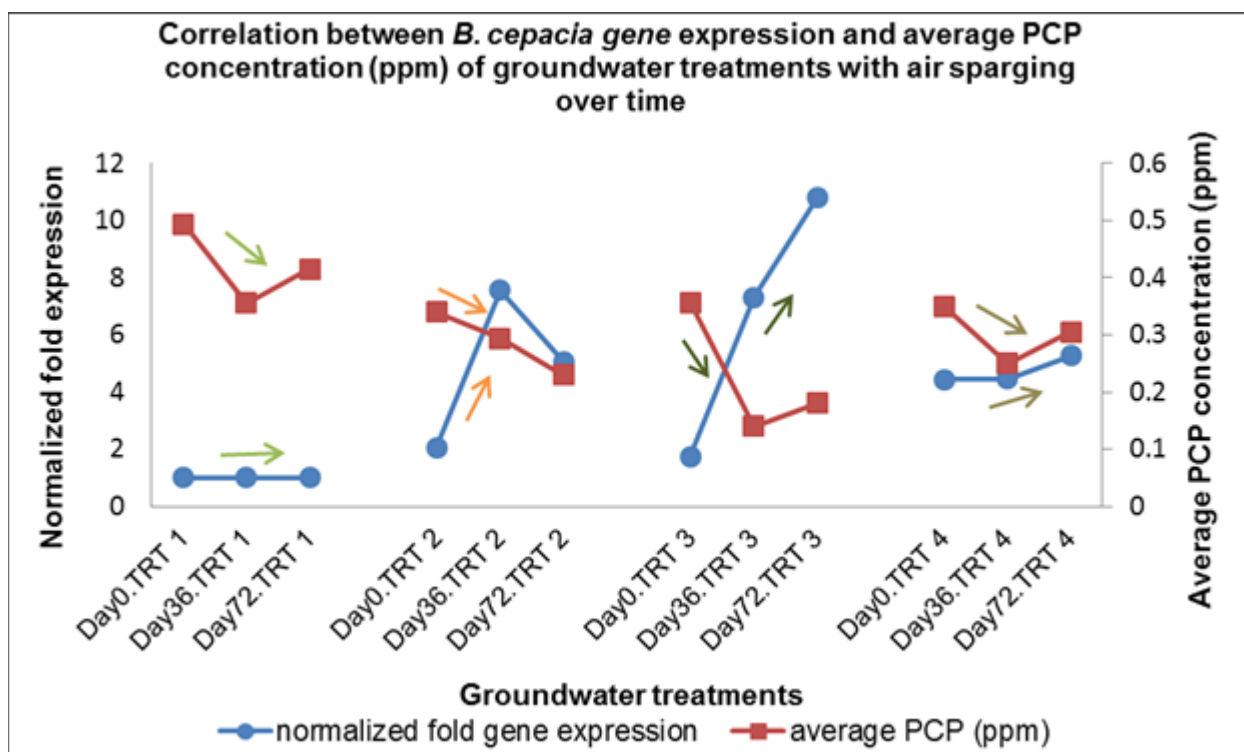


Figure 5 Correlation between *B. cepacia* gene expression and average PCP concentration (ppm) of groundwater treatments with air sparging (phase 2) over sampling days 0, 36 and 72. Treatments: TRT 1 = with Miracle Gro™, TRT 2 = Miracle Gro™ + *S. chlorophenolicum*, TRT 3 = Miracle Gro™ + *B. cepacia* and TRT 4 = Miracle Gro™ + *S. chlorophenolicum* + *B. cepacia*. There were three replicates per treatment. Correlation coefficient (r) = -0.8139.

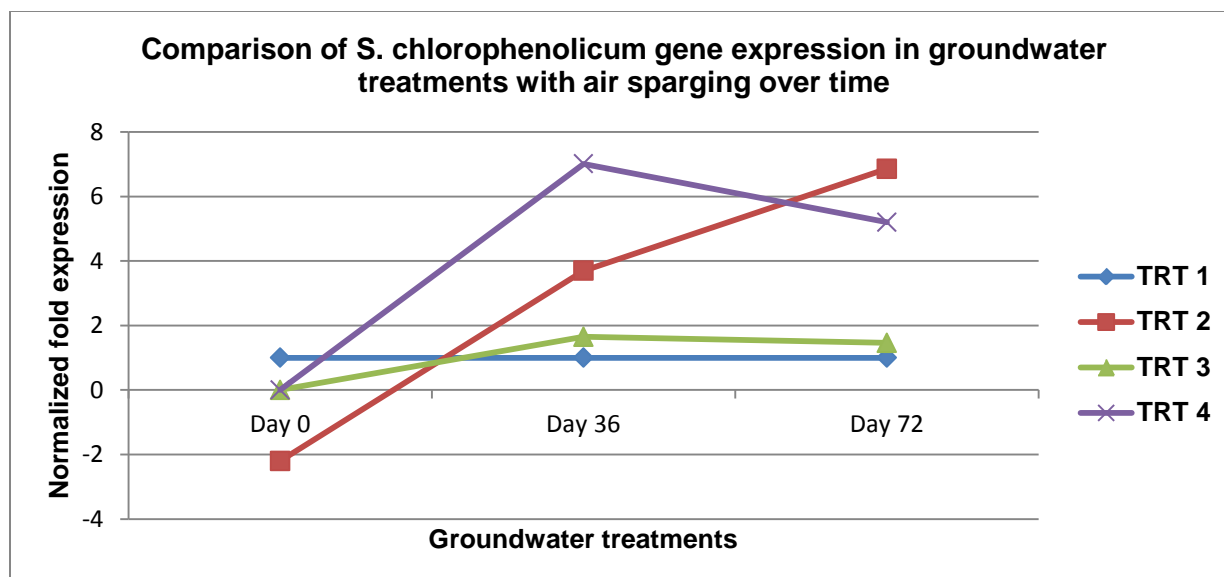


Figure 6 Comparison of *pcpB* (pentachlorophenol-4-monooxygenase) gene expression in groundwater treatments with air sparging (phase 2) over sampling days 0, 36 and 72. Treatments: TRT 1 = with Miracle Gro™, TRT 2 = Miracle Gro™ + *S. chlorophenolicum*, TRT 3 = Miracle Gro™ + *B. cepacia* and TRT 4 = Miracle Gro™ + *S. chlorophenolicum* + *B. cepacia*. There were three replicates per treatment.

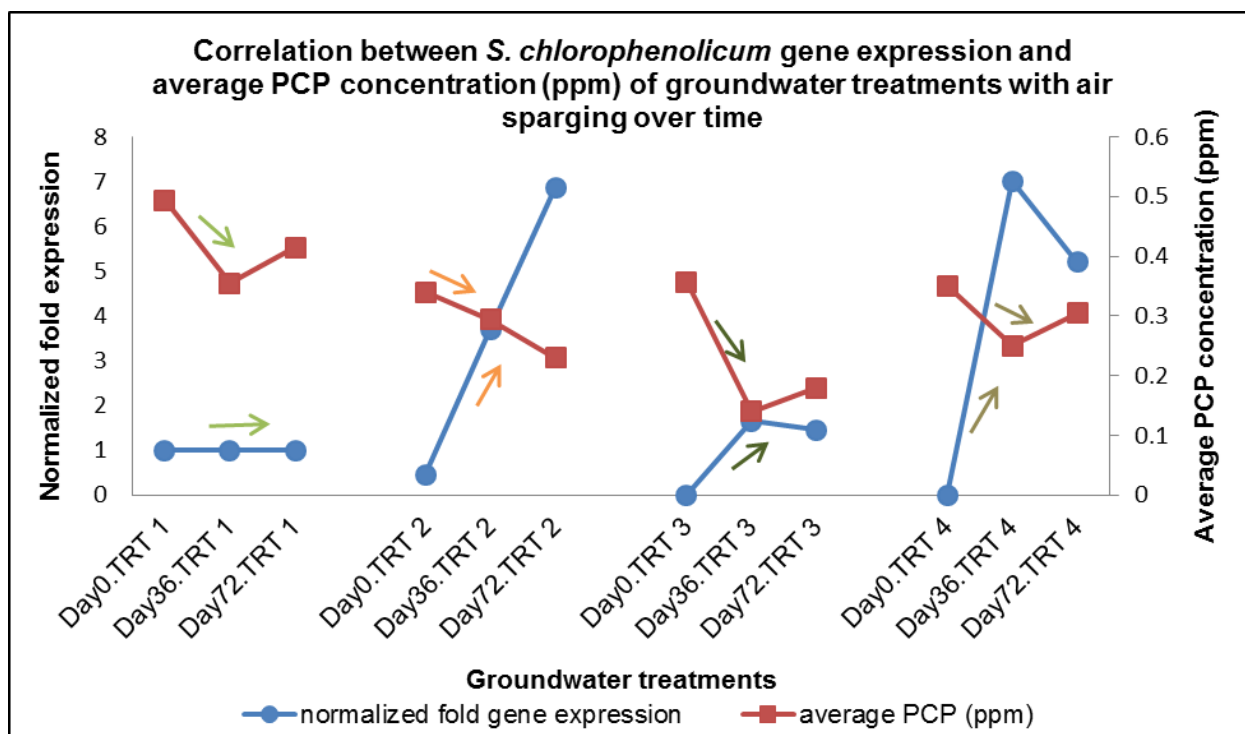


Figure 7 Correlation between *pcpB* expression and average PCP concentration (ppm) of groundwater treatments with air sparging (phase 2) over sampling days 0, 36 and 72. Treatments: TRT 1 = with Miracle Gro™, TRT 2 = Miracle Gro™ + *S. chlorophenolicum*, TRT 3 = Miracle Gro™ + *B. cepacia* and TRT 4 = Miracle Gro™ + *S. chlorophenolicum* + *B. cepacia*. There were three replicates per treatment. Correlation coefficient (r) = -0.4105.

Water-Conserving Irrigation Systems for Furrow & Flood Irrigated Crops in the Mississippi Delta

Basic Information

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Principal Investigators:	Joseph H. Massey

Publications

1. Quarterly reports 2011-2012 to Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS.
2. Massey, Joseph H. 2011. Water Conservation Practices for Rice Production in the Mid-South, USA. Irrigated Rice Congress of Brazil, Balneario Caboriu, Santa Catalina, Brazil. 10 August 2011. (Invited)
3. Massey, J. 2011. Yazoo Water Management District water meeting. September 14, 2011.
4. Massey, J. 2011. Water and Energy Conserving Irrigation Practices. Rice Short Course 15 November 2011. Stoneville, MS.
5. Massey, J. 2011. Water and Agriculture in the Mississippi Delta. Café Scientifique Starkville, MS 15 November 2011.
6. Massey, J. 2011. Intermittent irrigation of rice. Carbon Trading Kickoff meeting. Hosted by WinRock International and the White River Irrigation District. Stuttgart, AR. December 6, 2011.
7. Massey, J. Invited Panel Member on Water Issues in the Delta. AG EXPO Cleveland, MS 17 January 2012.
8. Massey, J. Invited speaker. Rice Consultants Meeting, Cleveland, MS. 19 January 2012.
9. Massey, J. Invited speaker. Arkansas Soil and Water Education Conference. Jonesboro, AR 26 January 2012.
10. Massey, J. and E. Kline. 2012. Cotton and Rice Conservation Systems Conference. Invited speakers. 31 Jan and 01 Feb. Tunica, MS.
11. Massey, J. 2012. Invited speaker. YMD Water Resources Conference. 08 February. Stoneville, MS.

Mississippi Water Resources Research Institute (MWRRI)
Final Project Report

**Water-Conserving Irrigation Systems for Furrow & Flood Irrigated Crops in the
Mississippi Delta**

Joseph H. Massey, Mississippi State University, 117 Dorman Hall, 662.325.4725,
jmassey@pss.msstate.edu

Abstract

The goal of this project was to improve irrigation water- and energy-use efficiency in one of the most economically important cropping rotations practiced in the Mississippi delta, the soybean-rice rotation. Combined economic activity for the two crops in the delta can approach \$1 billion annually while combined irrigation water use is approximately 1 million A-ft per season. As a result, a modest reduction in the amount of irrigation water used in the soybean-rice rotation could help reduce the current overdraft of the alluvial aquifer. Results from these 2010-2012 on-farm trials indicate soybean irrigation savings using NRCS Phacut optimization software averaged about 20% compared to non-optimized furrow irrigation while associated energy use reductions ranged from 32 to 20%, respectively. (It is important to note that in order to foster comparison, the soybean fields used in these studies were rectangular in shape; water savings are expected to be greater for more irregular (i.e., hard to irrigate) soybean fields.) Irrigation water used in rice grown using straight-levees with multiple inlets and intermittent flood management averaged 22.1 ± 2.4 A-in/A as compared to 32.4 A-in/A for straight-levee rice using multiple inlets without intermittent flood management. These results indicate that by overlaying an intermittent flood regime on practices that are already familiar to rice producers in Mississippi, rainfall capture is increased and over-pumping is decreased such that overall water use is reduced by ~40% over the standard rice irrigation practices. Field trials comparing rough rice yield and milling quality for up to 15 rice varieties indicated that commercial rice varieties, grown using standard fertility and pest control programs, well-tolerated a carefully-controlled intermittent flooding regime. Each inch of water not pumped from the Alluvial aquifer onto an acre of rice or soybean saves the energy equivalent of ~1 gallon diesel fuel with concomitant reduction in CO₂ emissions by ~200 lbs/A. Assuming a current off-road diesel price of \$3.20/gallon, a 9 acre-inch (40%) reduction in rice irrigation translates to a savings of ~\$20 per acre while a 1.7 acre-inch (20%) reduction in soybean irrigation represents a savings of ~\$3 per acre. By reducing irrigation water and associated energy inputs in soybean and rice production, the producer reduces input costs while relieving pressure on the Mississippi River Valley Alluvial aquifer and also reduces carbon emissions.

Critical Water Problem Addressed

The Mississippi River Valley Alluvial (MRVA) aquifer in the Mississippi delta has been experiencing groundwater declines for over twenty years (Figure 1). Reducing and reversing the decline in is important to the economic and ecological futures of Mississippi and the Nation.

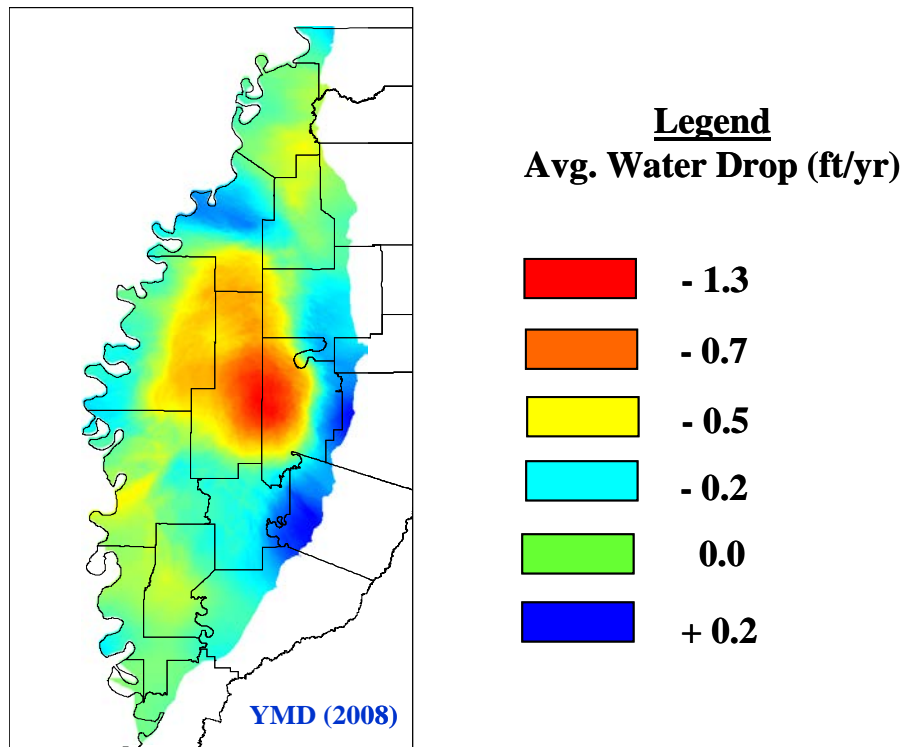


Figure 1. Average 20-yr decline in depth of alluvial aquifer in the Mississippi delta. (YMD, 2008)

Project Objectives

The goal was to develop water-conserving irrigation practices for soybean and rice production to reduce overall withdrawals from the MRVA aquifer. Specific objectives were:

Objective 1: Compare season-long water and energy use, and grain yield for soybean grown using furrow irrigation systems optimized using the NRCS Phaucet program and pump timers to that of non-optimized furrow irrigated soybean.

Objective 2: Compare season-long water and energy use, grain yield, and grain quality for rice grown using multiple-inlet irrigation with intermittent flood management and depth gauges to rice grown using only multiple-inlet irrigation.

Objective 3: Using input from producers and crop consultants, refine approaches developed in Objectives 1 and 2 to create systems that can be readily adopted across the Mississippi delta.

Related Research

The Lower Mississippi River Valley (LMRV) is one of the most productive agricultural regions in the United States. Aquaculture, corn, cotton, rice, soybean and other crops generate nearly \$6.8 billion/yr in revenue and employ about 100,000 while transportation on the lower Mississippi River accounts for another \$6 billion/yr and 29,000 jobs (Black et al., 2004). Owing to frequent extended periods of dryness during the growing season, supplemental irrigation is necessary for optimal yields and economic returns (Heatherly and Hodges, 1999). More than 3 million ha of irrigated cropland exist in the LMRV (USDA NASS, 2007), making it one of the most heavily irrigated regions in the U.S. (Figure 2). During the mid-1990s to early 2000's, roughly 77,000 ha of new cropland came under irrigation each year (Evelt et al., 2003).

The Mississippi River Valley Alluvial (MRVA) aquifer (Figure 1) supplies about 90% of the irrigation in the LMRV. The water withdrawal rate from the aquifer is 9,290 Mgal/d and ranks second only to the High Plains aquifer (17,500 Mgal/d) in terms of irrigation use (Maupin and Barber, 2005). The aquifer is an unconsolidated sand and gravel aquifer at, or near, the land surface that ranges in thickness from about 7 to 45 m (Arthur, 2001). In portions of Arkansas and Mississippi, the aquifer is declining at rates ranging from 0.15 to more than 0.45 m per year (ASWCC, 2010; YMD, 2010). This deficit could potentially be exacerbated by growing future demand for irrigation, for reasons explained below.

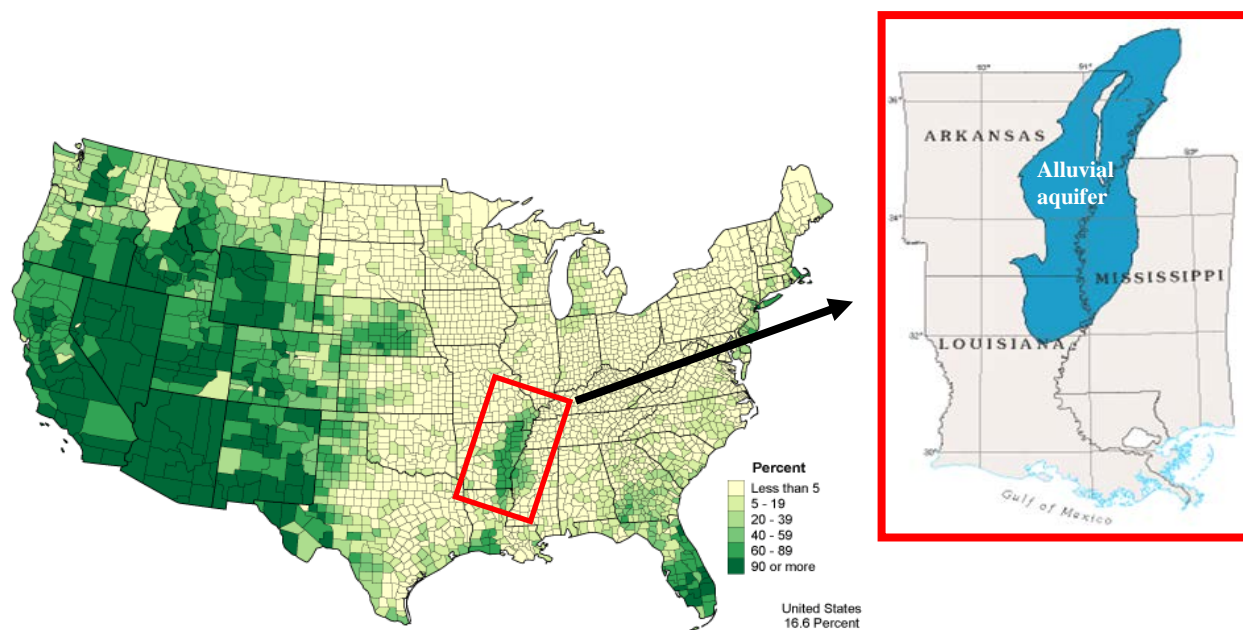


Figure 2. Irrigated harvested cropland in 2007, showing intensity of crop irrigation in the Lower Mississippi River Valley (LMRV) and boundaries of the Mississippi River Valley Alluvial (MRVA) aquifer (inset). (Modified using graphs from USDA NASS and USGS).

Recent climate projections indicate that summers in the LMRV may become hotter and drier and winters will become warmer with above normal precipitation (Kunkel et al., 2011; Fig. 3). The impacts that such changes might have on net aquifer recharge are unknown, but clearly increased summertime temperatures coupled with reduced in-season rainfall could be expected to increase soil moisture deficits and, thus, irrigation demand.

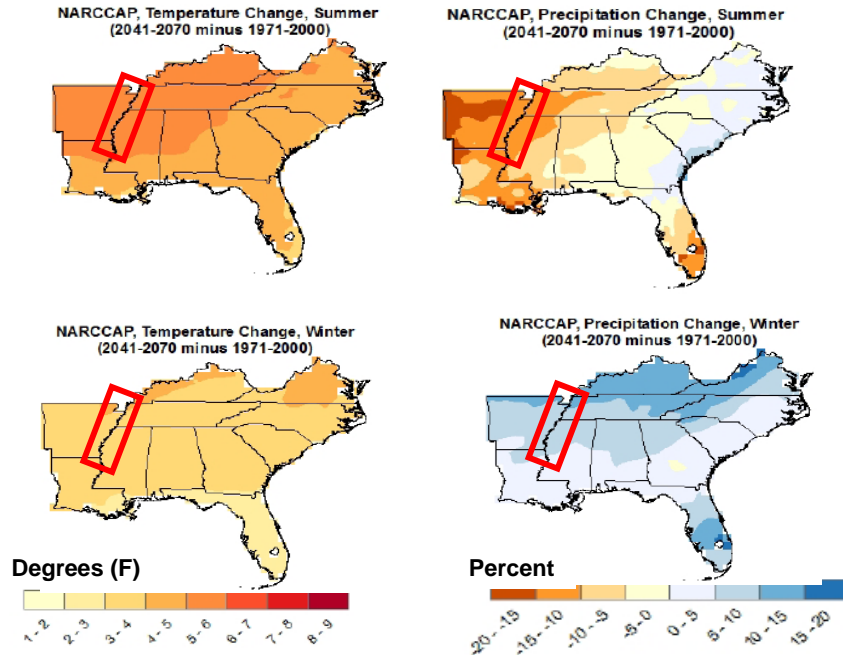


Figure 3. Summer and winter temperature and precipitation projections for the southeastern U.S. (modified using graphs from Kunkel et al., 2011)

In addition to the climate projections for the LMRV, Seager et al. (2007) anticipate that the **southwestern** U.S. will undergo progressive warming and drying (Fig. 4), increasing demand for irrigation (Cayan et al., 2010) while decreasing water availability, exacerbating competition for water in a region already experiencing declines in irrigated crop acreages (NASS, 2007). If this occurs, the agricultural and water resources in the LMRV will be increasingly relied upon by a nation seeking to compensate for declines in agricultural productivity in the southwest.

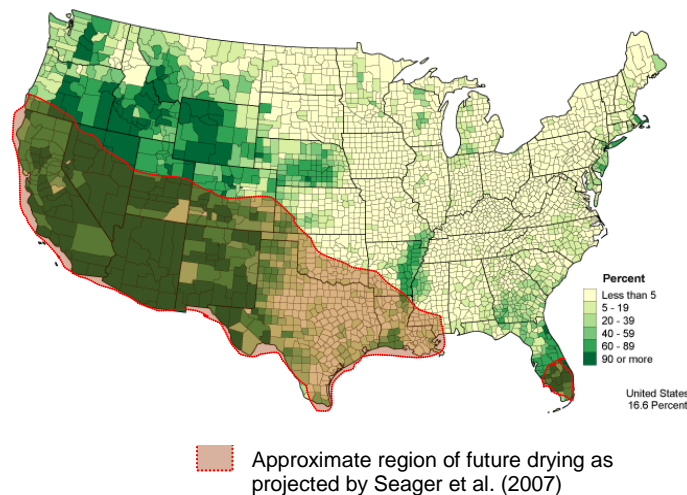


Figure 4. 2007 irrigated harvested cropland with overlay of southwestern region of the U.S. that is projected to progressively dry in the future. (NASS graphic modified using Seager et al. (2007) projections)

Demand for irrigation will also increase as agricultural input costs increase (Figure 5) because farmers will need to protect their substantial investments. Irrigation is one of the surest ways to reduce risk and protect against the vagaries of hot, dry weather that is projected to increase in the LMRV (Fig. 3).

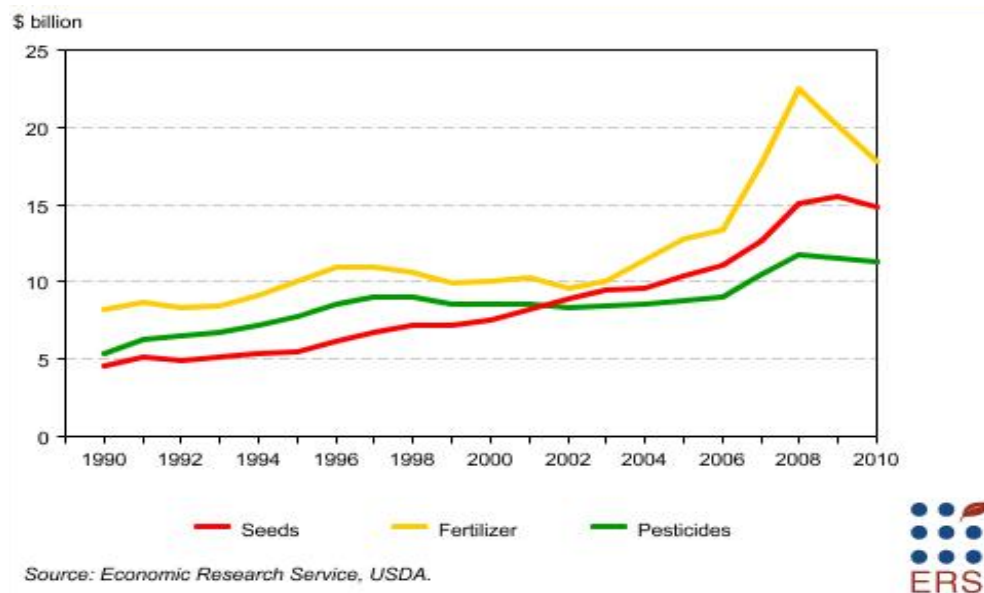


Figure 5. Total expenditures for seeds, fertilizers, and pesticides by U.S. farms. (Source: USDA Economic Research Service.)

The above climate projections and rising input cost and commodity price trends suggest that demand for irrigation water in the LMRV could grow in coming decades. As the areal recharge of the aquifer occurs at a nearly steady rate averaging about 2.5 inches per year (Arthur, 2001), such an increased demand for irrigation will exacerbate the current overdraft of the MRVA aquifer unless the total amount of water withdrawn from the MRVA aquifer is reduced by (a) reducing the total irrigated acreage such as by growing more non-irrigated or drought-tolerant crops, (b) use of significantly more efficient irrigation practices, (c) exploitation of new source(s) of irrigation water, or (d) augmentation of aquifer recharge using surface water. Most likely, combinations of these options will have to be used to meet increasing demands for irrigation while protecting the future viability of the MRVA aquifer.

This WRRI-funded project investigated improved irrigation methods for soybean (*Glycine max.*) and rice (*Oryza sativa*). Irrigation water used in the production of rice and soybean is approximately one million acre-feet per year or approximately one-half the current removal of irrigation water from the alluvial aquifer in Mississippi. The research performed in this project was conducted in the Mississippi delta, but should be generally applicable to other agricultural areas in the LMRV.

Project Description

The 2:1 soybean-rice crop rotation is an approximately three year rotation practiced on nearly one million acres in the Mississippi delta. This rotation can produce a combined economic activity that approaches \$1 billion annually but also currently uses approximately one million A-ft of irrigation water

per season (Table 1). As a result, a modest reduction in the amount of irrigation water used in the soy-rice rotation could theoretically¹ help to reduce overdraft of the alluvial aquifer.

Table 1. Average irrigation water used by row crops in the Mississippi delta (YMD, 2010).

Crop	2009 Acres (thousands)	Avg. H₂O Use (Ac-ft/Ac)	Estimated Seasonal Water Use (Ac-ft)
Rice	200*	3	600,000
Corn	900	0.8	720,000
Soybeans	2,500* (Delta only: 1,750)	0.7	Delta irrigated only: 796,000
Cotton	270	0.5	135,000
Fish	70	1.9	133,000

* 100% of the rice and ~70% of the soybeans grown in MS occur in the Mississippi delta; approximately 65% of the delta-grown soybeans are irrigated.

Approximately 50% of delta-grown soybeans are produced on raised beds and irrigated down the furrows using plastic tubing as shown in Figure 6. The USDA NRCS *Phaucet* irrigation computer program² optimizes hole size and number in plastic tubing, improving irrigation efficiency by 25% or more according to research conducted in Arkansas (Tacker, 2008). The *Phaucet* program requires that the overall field dimensions (row lengths and widths) and slope of the field (total head pressure, in feet) and flow rate of the irrigation pump (gallons per minute) be known. Using this information and the dimensions of the plastic tubing, the program calculates the optimal hole sizes and numbers to distribute water evenly across irregularly-shaped fields.



Figure 6. The furrow irrigation of crops can be optimized using the NRCS *Phaucet* program that determines optimal hole sizes and numbers in plastic tubing using row lengths, field slope, flow rate of well, and tubing specifications.

¹ Assumes that water saved by improved irrigation efficiency is not used for other crops or purposes. See Pfeiffer and Lin (2010) for an example where technology used for water conservation led to more actual water use.

² The USDA NRCS *Phaucet* program is available at link below:
(http://www.wsi.nrcs.usda.gov/products/w2q/water_mgt/irrigation/irrig-mgt-models.html)

The majority of rice in Mississippi is produced in straight-levee fields that have been precision-leveled to have uniform slopes of 0.1 to 0.2% (Figure 7) allowing straight levees to be placed perpendicular to the slope at regular intervals of ~ 180 ft. In approximately 20% of the straight-levee fields, plastic tubing is used to distribute floodwaters across the field in a practice called multiple- or side-inlet irrigation. Approximately 5% of rice is grown on zero-grade or “level basin” fields that have no slope and, thus, require no levees. The acres of rice grown using traditional contour levees that follow the natural contour of the field are decreasing with each passing year, but is estimated to be about 30% of production in 2009.

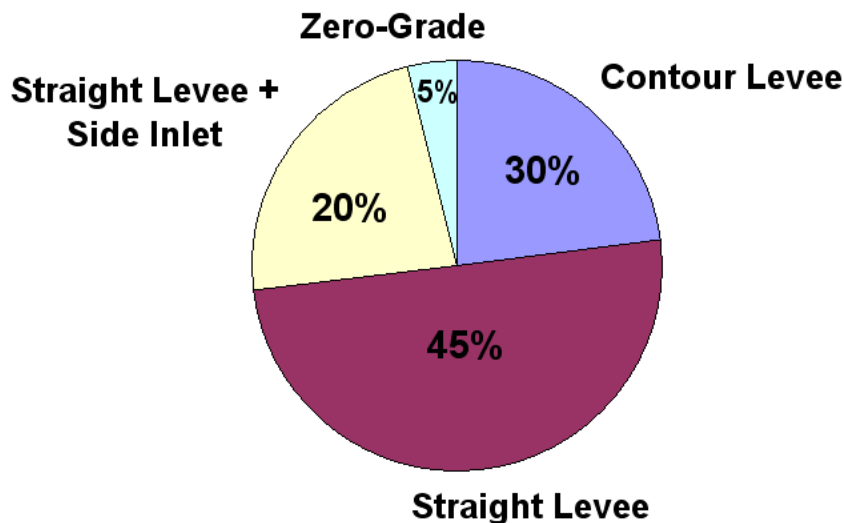


Figure 7. Approximate percentages of rice levee systems used in Mississippi delta in 2009. (Estimates based on MSU extension farmer and consultant surveys, and YMD permitted well meta information.)

Depending on soil series, cultivar, and prevailing weather, rice grown in the Mississippi delta generally needs somewhere between 14 to 25 inches water (1.1 to 2.1 A-ft/A) per 80-day flood. This range, which represents contributions from rainfall and irrigation, are based on research conducted by Pringle (1994) using cultivars (Table 2) and rice soils (Table 3) in Mississippi. Rainfall during these studies conducted in 1991 and 1993 was 66.5% and 97.9% of rainfall average, respectively.

Table 2. Average evaporation-transpiration (ET) losses measured by Pringle (1994) for four rice varieties grown in the Mississippi delta in 1991 and 1993.

Variety	Measured ET (inches)
Rosemont	12.8 ± 3.0
Maybelle	13.6 ± 1.7
Newbonnet	15.7 ± 2.2
Lemont	16.7 ± 2.1

Table 3. Average deep percolation losses measured by Pringle (1994) for four Mississippi rice soils in 1991 and 1993.

Soil Series Name	Inches Water Lost over an 80-day Flood
Sharkey	12.8 ± 3.0
Alligator	13.6 ± 1.7
Forestdale	15.7 ± 2.2
Brittain	16.7 ± 2.1

Zero-grade systems use the least amount of applied irrigation water of the rice levee systems currently in use in Mississippi (Figure 8). However, they still routinely apply more than the 14-25 A-in/A seasonal water requirement determined by Pringle (yellow box) when average seasonal rainfall (10 to 14 in) is taken into account. Moreover, owing to water-logging issues for the soybean rotation, adoption of zero-grade has been limited to approximately 5% of rice acreage (Figure 7). To avoid the issues of water-logging, certain producers grow rice continually without rotation. This may lead to issues such as weed resistance and is generally not recommended. This WRII project builds upon research conducted at Mississippi State University designed to extend the water savings of multiple-inlet rice irrigation (MIRI) by using intermittent (less-than-full) flood management designed to optimize rainfall capture and reduce over-pumping of rice paddies.

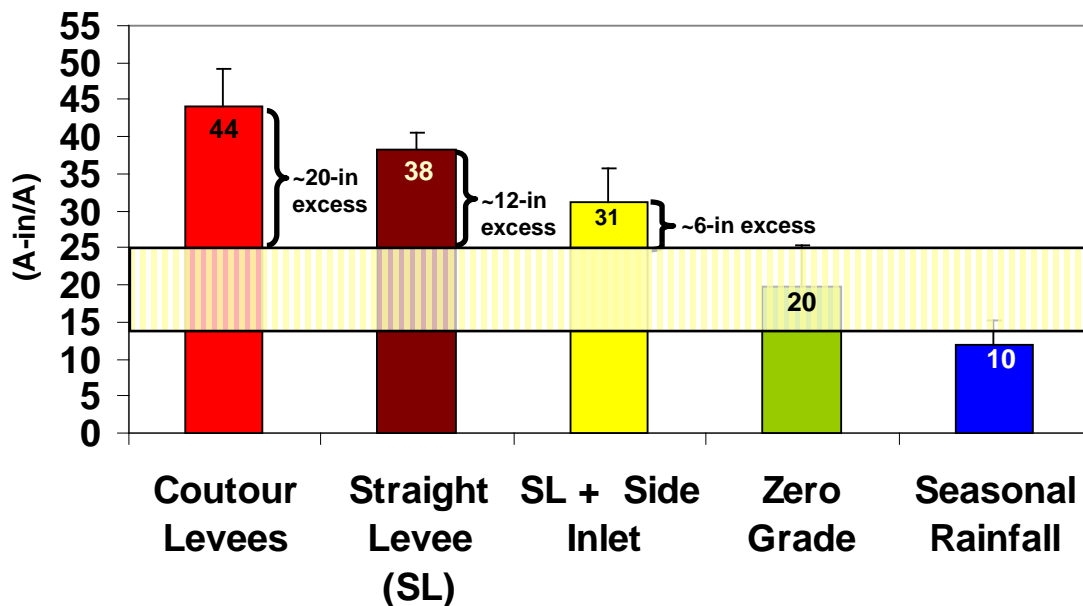


Figure 8. Six year average water use (A-in/A) values for different rice levee systems (YMD, 2010) shown with range (yellow box) of water use requirements (ET plus deep percolation) for rice as determined by Pringle (1994) in Mississippi.

Intermittent irrigation (Bouman and Tuong, 2001) is a method of rice water *management* that, when coupled with multiple-inlet rice irrigation (MIRI) (Tacker et al., 2002), can greatly reduce water use in rice production. Once the initial flood is achieved, pumping is halted and the flood is allowed to naturally subside until approximately one-third to one-half of the soil in the upper rice paddy is exposed as (water-saturated) mud. At this time, irrigation is resumed and the flood reestablished. This cycle may be repeated roughly every 5 to 9 days, depending on prevailing weather and soil conditions (Figure 9). The key benefits are increased rainfall holding capacity and reduced over-pumping that essentially eliminates loss of runoff from the field. The practice of intermittent flooding is greatly facilitated by use of multiple-inlet irrigation as MIRI (a) allows the flood to be quickly reestablished after the drying cycle, thus reducing potential for rice stress, and (b) allows the rice paddies to be managed as separate entities.

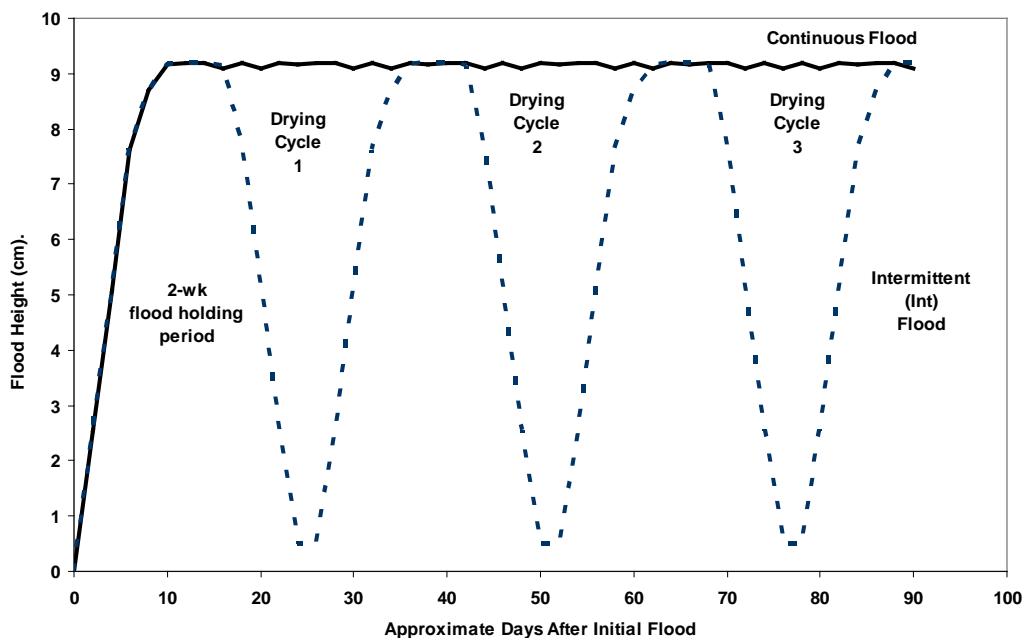


Figure 9. Diagram demonstrating approximate flood patterns and depths in rice paddies maintained using continuous (solid line) and intermittent (dashed line) flooding.

Methods, procedures, and facilities:

Soybean Irrigation Studies

These studies were conducted as on-farm, production-scale studies consisting of side-by-side comparisons between conventionally irrigated (control field) and optimized irrigation systems (treatment field). Three producer sites consisting of four fields per site were studied. The four fields at each field site consisted of two similarly-shaped fields planted to soybean (one control field, one treatment field). The fields were selected to minimize potential differences in soil texture and fertility, field shape and slope, crop cultivar, and irrigation well size and capacity. The control and treatment fields were managed by the producer. All agronomic inputs and management conditions were documented. The specific parameters measured are given in Table 4.

Table 4. Research parameters measured for the soybean irrigation trials.

Parameter	How Measured	Frequency
Seasonal Water Use	McCrometer odometer-type flowmeter.	Weekly readings to harvest for total water use.
Rainfall	Tipping bucket raingauge	Daily total.
Grain yield	Calibrated yield monitor	At harvest
Number of irrigations	Recorded in notes.	As needed.
Energy Consumption (electric only)	Electric meter readouts.	At beginning and end of study.

Rice Irrigation Studies

For the rice studies, between 8 to 15 commercial rice varieties or hybrids were planted via grain drill at the top and bottom of a paddy located in a commercial straight-levee rice field where multiple-inlet irrigation was used to distribute the flood and the flood was managed intermittently. The intermittent flood consisted of the farmer allowing the flood to naturally subside to a point where mud was exposed in the upper one-third to one-half of the paddy. At this point, the farmer would again flood the paddy. This caused the plots planted in the upper portion of the paddy to undergo wetting and drying cycles while the plots in the lower portion of the paddy remained flooded. This facilitated the determination of the effects that intermittent flooding had on yields and milling quality as compared to the continuously-flooded plots. The specific parameters measured are given in Table 5.

Table 5. Research parameters measured for the rice irrigation trials.

Parameter	How Measured	Frequency	Comments
Seasonal Water Use	McCrometer odometer-type flowmeter	Weekly readings to harvest for total water use	
Paddy flood height	Global Water Water Level Logger Sensor	20-min intervals	Used to determine number and extent of dry down periods and estimate rainfall capture.
Grain yield	Calibrated yield monitor	Upper paddy vs. Lower paddy samples	Compare upper paddy vs. lower paddy to highlight potential negative impacts on grain yield and quality.
Grain quality	MSU testing facility or similar	Upper paddy vs. Lower paddy samples	

Results & Discussion

Furrow Irrigation of Soybean Studies

Water use and soybean yield results from the 2010 and 2011 field trials comparing farmer versus Phaucet-optimized furrow irrigation designs are given in Table 6. On average, Phaucet-designed hole sizes and hole spacings reduced water and energy use by approximately 20% while yields were either the same or slightly higher than the farmer irrigation designs. The Phaucet program improves the efficiency of irrigation by improving the evenness in which water is distributed across the field. Using Phaucet, water should reach the end of long rows and short rows at more or less the same time. This saves water and energy because the farmer does not have to run water off shorter rows while waiting for longer rows to finish watering. In those cases where the Phaucet-design yields were higher than the non-optimized designs, reduced water-logging of soils from excessive irrigation is a potential explanation, pointing to another potential benefit of improved furrow irrigation.

It is important to note that:

A. These results were obtained from fields that were regularly shaped (square to rectangular) that were chosen to facilitate comparison between the two irrigation design treatments (i.e., with and without Phaucet optimization). In actual use, one would expect that water savings could be greater for more irregularly-shaped fields that are more difficult to irrigate than the more symmetrical fields investigated in this study.

B. The water and energy savings gained by using Phaucet could be lost if the irrigation set were allowed to run longer than needed. For example, if a farmer expects that a set will finish early in the morning, say at 2 am, but s/he can't return to shut off the well off until 7 am, excess water could runoff the field, reducing the water and energy savings normally associated with a Phaucet-optimized design. By installing a 24-hour spring-wound timer, as some farmers are doing on both electric and non-electric wells, the efficiency gains of Phaucet may be better captured as the farmer can set the timer to shut the well off at say 3 am (to build in a fudge factor). The farmer can then check the field and assess how well the crop was watered at a time more convenient to their schedule. Based on the 20% savings observed in this study and assuming diesel costs of approximately \$3.50/gallon, the timers could pay for themselves in about two seasons.

Table 6. Water Use, Number of Irrigation, and Soybean Yield Results for Furrow Irrigation Trials Comparing Farmer Design with Optimized Design Using the NRCS Phaucet Program.

Field Name Year	Design Treatment	Field Size (A)	Water Use (A-in)	No. of Irrigations	A-in per Irrigation	Soybean Yield (bu/A)
Lost 40						
2010	Farmer	16	20	5	4.0	62
	Phaucet	15	19	6	3.2	62
2011	Farmer	15	20	5	4.0	50
	Phaucet	16	16	4	4.0	53
16th Section						
2011	Farmer	19	15	3	5.0	49
	Phaucet	19	12	3	4.0	49
Tillman-A/B						
2011	Farmer	34	17	4	4.3	34
	Phaucet + Timer	41	14	4	3.5	43
Tillman-C/D						
2011	Farmer	52	11	3	3.7	45
	Phaucet + Timer	44	12	4	3.0	48

Rice Irrigation using Intermittent Flooding

As many as 8 wetting-drying cycles have been performed by Mississippi rice growers involved in this research, resulting in paddies being maintained in a “less-than-full” status throughout much of the growing season (Figure 10). This greatly improves capture of the 10 to 14 inches of rainfall that falls during an average delta growing season. On average, rice grown using multiple-inlet irrigation with intermittent flood management used approximately 5% more water than zero-grade systems (Figure 11). The advantage of the former being that it is applicable to most straight-levee systems under which the majority of rice in Mississippi is grown (Figure 7).

Results from 2010, 2011, and 2012 were similar for rice yields and grain milling quality (data not shown). Rough rice yields (lbs/A; corrected for moisture) for the upper, intermittently-flooded plots were either unchanged ($p > 0.05$) or slightly higher ($p < 0.05$) than those of the bottom, continuously-flooded plots (Tables 7 and 8). This is in agreement with research that indicates that rice grown under intermittent irrigation often yields higher than when it is continuously flooded (Zhang et al., 2008). These research further indicate that rice can be grown successfully in the Mississippi delta using multiple-inlet plus intermittent rice flood irrigation practices.

Table 7. Representative results from 2011 comparing rice yields for from top of paddy plots (intermittent irrigation) and bottom of paddy plots (continuous flood) for eight rice varieties and one hybrid. (Seasonal rainfall was 7.6 inches. The upper plots underwent eight wetting-dry cycles while the lower underwent one cycle in early-July. Total irrigation water applied to this 38-A field was 18 A-in/A. Soil type was clay. Previous crop was soybean.)

Rice Variety/Hybrid	2011 Rough Rice Yield (lbs/A)		p-value
	Top of Paddy	Bottom of Paddy	
	(8 wet-dry cycles)	(1 wet-dry cycle)	
CL111	11086	10490	0.0855
CL131	10189	9594	0.0107
CL142	10819	11486	0.2517
CL151	11276	10672	0.0801
CL152	10001	9056	0.0453
CL162	10072	10218	0.5115
CL181	8141	8452	0.5492
CLXL745	11314	12246	0.1284
Global Comparison	10350	10277	0.8102

Table 8. Representative results from 2010 comparing rice yields for from top of paddy plots (intermittent irrigation) and bottom of paddy plots (continuous flood) for eight rice varieties and one hybrid. (Seasonal rainfall was 10 inches. The upper plots underwent five wetting-dry cycles while the lower underwent one cycle in early-July. Total irrigation water applied to this 73-A field was 23 A-in/A. Rainfall was 10 in. Soil type was clay.)

	2010 Rough Rice Yield (lbs/A)		
Rice Variety/ Hybrid	Top of Paddy	Bottom of Paddy	p-value
	(5 wet-dry cycles)	(1 wet-dry cycle)	
6004	10,548	9,067	0.0326
Bowman	9,838	9,905	0.9004
CL111	10,850	11,380	0.5048
CL131	9,142	9,762	0.2304
CL142	11,605	10,489	0.0643
CL151	11,428	10,852	0.2763
CL181	9,588	9,278	0.6637
CLX745	12,386	11,698	0.1889
Cheniere	10,576	10,124	0.1017
Cocodrie	10,796	10,528	0.2154
Neptune	10,396	9,452	0.0756
Rex	10,481	9,899	0.1846
Taggart	11,486	10,961	0.3535
Templeton	11,083	9,933	0.0618
XL723	12,809	12,808	0.9986
Global comparison	10,888	10,352	0.00677

Figure 10. Representative results from 2011 showing intermittent rice irrigation pumping pattern for variety trial. (Blue line represents flood depth at top of paddy; red line represents depth where mud was exposed in upper 1/3 to 1/2 of paddy. Seasonal rainfall was 7.6 inches. The upper plots underwent eight wetting-dry cycles while the lower underwent one cycle in early-July. Total irrigation water applied to this 38-A field was 18 A-in/A. Soil type was clay. Previous crop was soybean.)

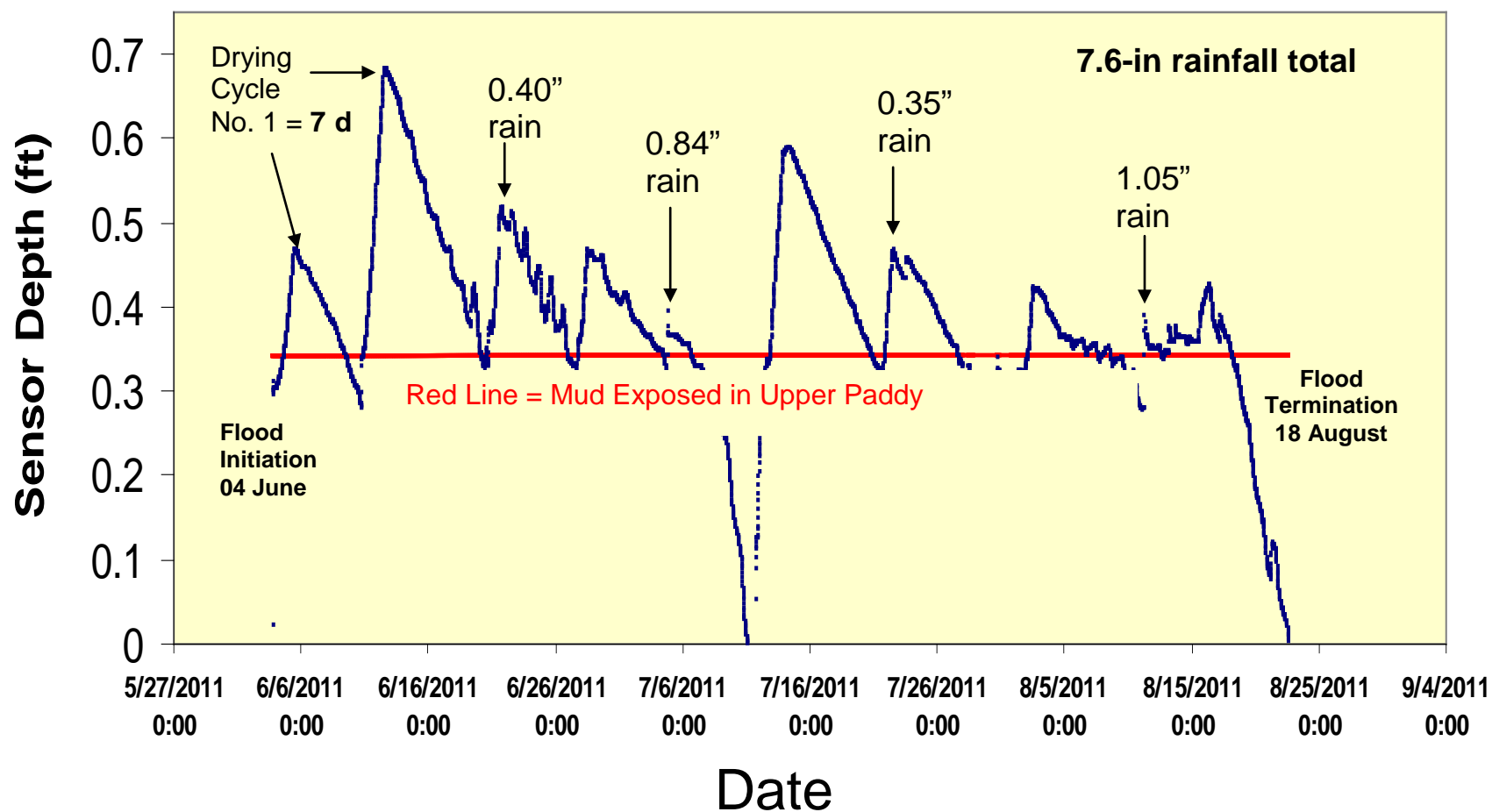
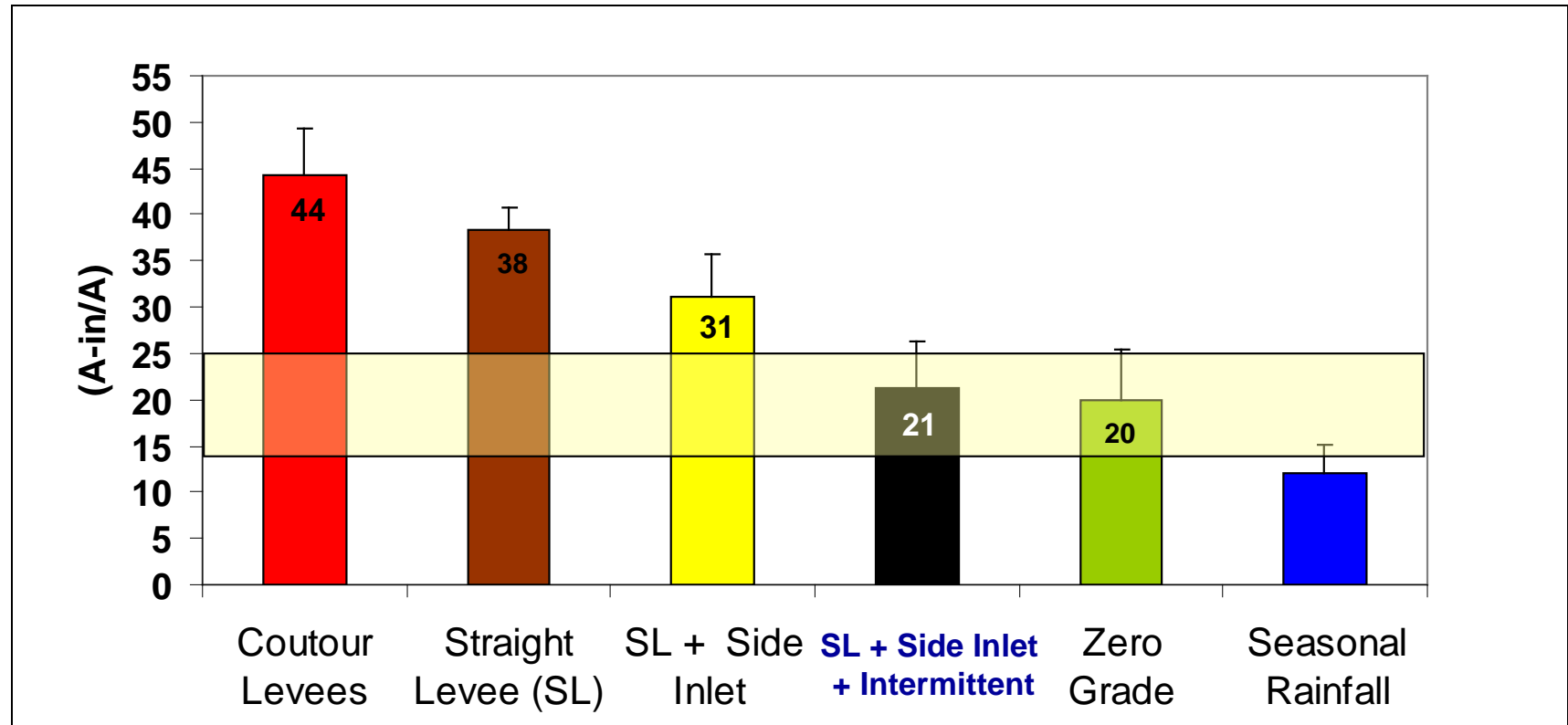


Figure 11. Average water used by intermittent rice irrigation trials (A-in/A) as compared to water use for different rice levee systems (YMD, 2010) shown with range (yellow box) of water use requirements (ET plus deep percolation) for rice as determined by Pringle (1994) in Mississippi.



Conclusions

These data support the premise that readily-available technologies and management strategies such as the NRCS Phaucet furrow irrigation optimization program, improved crop genetics, pump timers, flood depth gauges, and intermittent irrigation practices can be combined within cropping rotations to significantly reduce water and energy use while maintaining economically-viable yields. Each inch of water not pumped from the MRVA aquifer onto an acre of rice or soybean saves the energy equivalent of approximately 1.0 gallon diesel fuel and reduces CO₂ emissions by ~200 lbs per A. Given an off-road diesel price of \$3.20/gallon, the 9 acre-inch (40%) reduction in rice irrigation demonstrated in this study translates to a savings of ~\$20 per acre while a 1.7 acre-inch (20%) reduction in soybean irrigation represents a savings of ~\$3 per acre. By reducing irrigation water and associated energy inputs in the soybean-rice rotation, the producer can reduce input costs, relieve pressure on the MRVA aquifer, and also reduce carbon emissions.

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Presentations & Outreach

PSS Departmental Seminar, 04 Oct 2010. Agriculture and the Mississippi Delta. Mississippi State University.

Earth Day week talk MSU April 19, 2010. Water and Agriculture in the Mississippi Delta. Starkville, MS.

YMD Board of Directors Meeting. 2010. Reducing Water Use in Mississippi Rice Production: Opportunities and Challenges. Leland, MS. 21 April 2010

Yazoo Water Management District Water Meeting. Efficient Irrigation Systems Overview. Stoneville, MS 10 Nov 2010.

Mississippi Water Resources Research Institute Annual Conference. Water-Conserving Irrigation Systems for Furrow & Flood Irrigated Crops in the Mississippi Delta. Bay St. Louis, MS. 04 November 2010.

Crop College-Starkville. Irrigation Efficiency Research: Soybean and Rice. Feb 17, 2011.

Irrigated Rice Congress of Brazil, Balneario Caboriu. Water Conservation Practices for Rice Production in the Mid-South, USA. Santa Catalina, Brazil. 10 August 2011.

Yazoo Water Management District water meeting. September 14, 2011.

First Year Lecture: Conservation Heroes. 21 September 2011. Starkville, MS.

Rice Short Course. Water and Energy Conserving Irrigation Practices. 15 November 2011. Stoneville, MS.

Café Scientifique. Water and Agriculture in the Mississippi Delta. Starkville, MS 15 November 2011

Carbon Trading Kickoff meeting. Intermittent irrigation of rice. Hosted by WinRock International and the White River Irrigation District. Stuttgart, AR. December 6, 2011.

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Rice Consultants Meeting, Cleveland, MS. 19 January 2012.

Arkansas Soil and Water Education Conference. Jonesboro, AR 26 January 2012.

Cotton and Rice Conservation Systems Conference. 31 Jan and 01 Feb 2012. Tunica, MS.

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Developing rapid methods for dating of sediments in Mississippi using ICP-MS

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**DEVELOPING RAPID METHODS FOR DATING SEDIMENTS
IN MISSISSIPPI USING ICPMS**

Final Project Report

By

James Cizdziel

Department of Chemistry & Biochemistry
The University of Mississippi

Submitted to Mississippi Water Resources Research Institute

August 2012

ABSTRACT

Sediment cores from seasonal wetland and open water areas from Oxbow lakes [Beasley (BL), Hampton (HL), Washington (WL), Roundaway (RL), Sky (SL) and Wolf (WL)] in the Mississippi Delta, whose chronology was previously determined by conventional ^{210}Pb and ^{137}Cs age-dating, were analyzed, for the first time, for Pu isotopes (^{239}Pu and ^{240}Pu), and Pb isotopes (^{206}Pb , ^{207}Pb , ^{208}Pb and ^{210}Pb). The primary purpose was to evaluate the feasibility of using ICPMS as an alternative to radiochemical analyses for fallout-Pu and ^{210}Pb .

For Pu, the mean $^{240}\text{Pu}/^{239}\text{Pu}$ atom ratio was ~ 0.177 indicating global fallout as the primary and likely source of the Pu. Analyses of an undisturbed sediment core yielded a Pu peak at a depth which is in good agreement with conventional ^{137}Cs and ^{210}Pb dating. Analysis of the Washington Lake sediment core yielded a Pu vs. depth profile that was broad and uncharacteristic of normal sedimentation patterns. It was later found out that the conventional dating technique also yielded data scatter indicative of sediment that was likely disturbed *in-situ*. Indeed, because sediment can be mixed by natural events after deposition, this demonstrates that ICPMS can serve as a useful tool to simultaneously identify (screen for) sediments that have been disturbed (eliminating costly ^{210}Pb analyses on such cores), and to provide a chronological marker for those that haven't (either alone or in conjunction with conventional dating).

For Pb, total concentrations varied from 1.5 ppm to 12 ppm, with peak levels generally occurring during the 1950's. Isotopic signature plots suggest "natural" Pb (from soil) as the primary source of the lead, with coal and gasoline as slight contributors; however, more study is needed to confirm this. Accurately measuring the ^{210}Pb isotope by ICPMS was problematic. The levels were low and subject to interference from stable isotopes of Pb, possibly by the tail of the large ^{208}Pb peak and/or from polyatomic interference such as $^{208}\text{Pb}^1\text{H}^1\text{H}$. To overcome these barriers, it is recommended to boost the sensitivity, possibly with a jet-face interface, and/or remove the interference using collision cell technology.

Information transfer: Publications resulting from this work include a paper in the 2012 Mississippi Water Resource Conference Proceedings. This work also contributed toward a Master's thesis by Ms. Pragma Chakravarty titled "Elemental and Isotopic Analysis of Sediments from Oxbow Lakes in the Mississippi Delta" (University of Mississippi, 2012). The current report contains elements from each of those reports.

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BACKGROUND AND PURPOSE OF STUDY

Sediments are complex deposits of inorganic and organic matter that can serve as a natural storage system for metals and anthropogenic contaminants. Because sediment cores can go back decades and even centuries, they are useful as environmental proxies providing a window on the past. Chronology of recent sediments (<100 years since deposition) is traditionally determined using ^{210}Pb and/or “bomb-pulse” isotopes, such as ^{137}Cs and $^{239+240}\text{Pu}$. These isotopes are commonly determined by radiochemical techniques, a process that is tedious and requires long analysis (count) times.

Sediment cores were collected from seasonal wetland (W) and open water (OW) areas from Oxbow lakes [Beasley (BL), Hampton (HL), Washington (WL), Roundaway (RL), Sky (SL) and Wolf (WL)] in the Mississippi Delta as part of previous studies by Dr. Davidson (UM Geology Department) and Dr. Wren (National Sedimentation Laboratory) [1, 2]. The core chronology was determined by conventional ^{210}Pb and ^{137}Cs age-dating and a number of trace elements were determined. Subsequently the dried sediment samples were archived in plastic bags and stored in boxes at room temperature.

In this study, these well-characterized sediment samples were, for the first time, analyzed for Pu isotopes (^{239}Pu and ^{240}Pu), and Pb isotopes (^{206}Pb , ^{207}Pb , ^{208}Pb and ^{210}Pb). The purpose was to: 1) assess temporal and spatial patterns of metal deposition in the region, and 2) evaluate the feasibility of using ICPMS for dating recent sediment by measuring fallout-Pu and ^{210}Pb in sediment profiles and comparing with conventional radiochemical dating methods. Specific objectives for each part of the study are given in their respective chapters. I am very grateful to our collaborators to have been given these sediment samples for this study.

SAMPLE SITES, SAMPLING, SAMPLE PREPARATION AND SEDIMENT CHRONOLOGY

Sediment cores were collected as a part of previous investigations by Dr. Davidson (UM Geology Department) and Dr. Wren (National Sedimentation Laboratory) [1, 2]. Detailed information on sample sites, sampling, sample preparation and sediment chronology are available from prior reports [1,2]. Briefly, cores were sampled using a vibracorer from both open water and wetland areas within six different Oxbow Lakes (Roundaway, Washington, Beasley, Wolf, Sky and Hampton) in the Mississippi Delta (Figures 1-3). Core identity, total watershed area, surface area, GPS specifications, core locations and maximum depth of the cores from six Oxbow Lakes are presented in Table 1. Plastic core pipes were inserted in the vibracorer before sampling. To account for compaction core depths were normalized to mean water content by the NSL. All lakes were sampled in 2009, except Wolf Lake and Sky Lake which were sampled in 2010 and 2006, respectively. The cores were stored at 4°C until processing. Cores were extruded soon after collection (within weeks) (except Sky Lake, which

was extruded in Sept. 2011) and sliced (figure 4) into 1cm (approx.) thick intervals, dried at 60°C in the oven, crushed and sieved through mesh of 1mm pore size. Once sieved the cores were stored at room temperature in labeled plastic bags. The cores were dated using both ^{210}Pb and ^{137}Cs analyses using conventional radioanalytical techniques as described elsewhere.

Table 1. Sample Information

Lake	Latitude (N)	Longitude (W)	Surface Area (Ha)	Watershed Area (Ha)	Sample ID	Core Location	Maximum Depth (cm)
Beasley	33.2408°	90.4032°	25	915	BL1A	Open Water	97
					BL2	Wetland	58
Hampton	33.8436°	90.2353°	NA	NA	HL2A	Open Water	333
					HL9	Wetland	134
Washington	33.0253°	91.0246°	1260	10,995	LW1A	Open Water	126
					LW2	Wetland	211
Sky	33.2888°	90.4985°	NA	1860	SL5	Open Water	136
Wolf	32.5563°	90.2799°	450	11,750	WF1	Wetland	126
Roundaway	34.0125°	90.3574°	21	1254	RL1B	Wetland	71

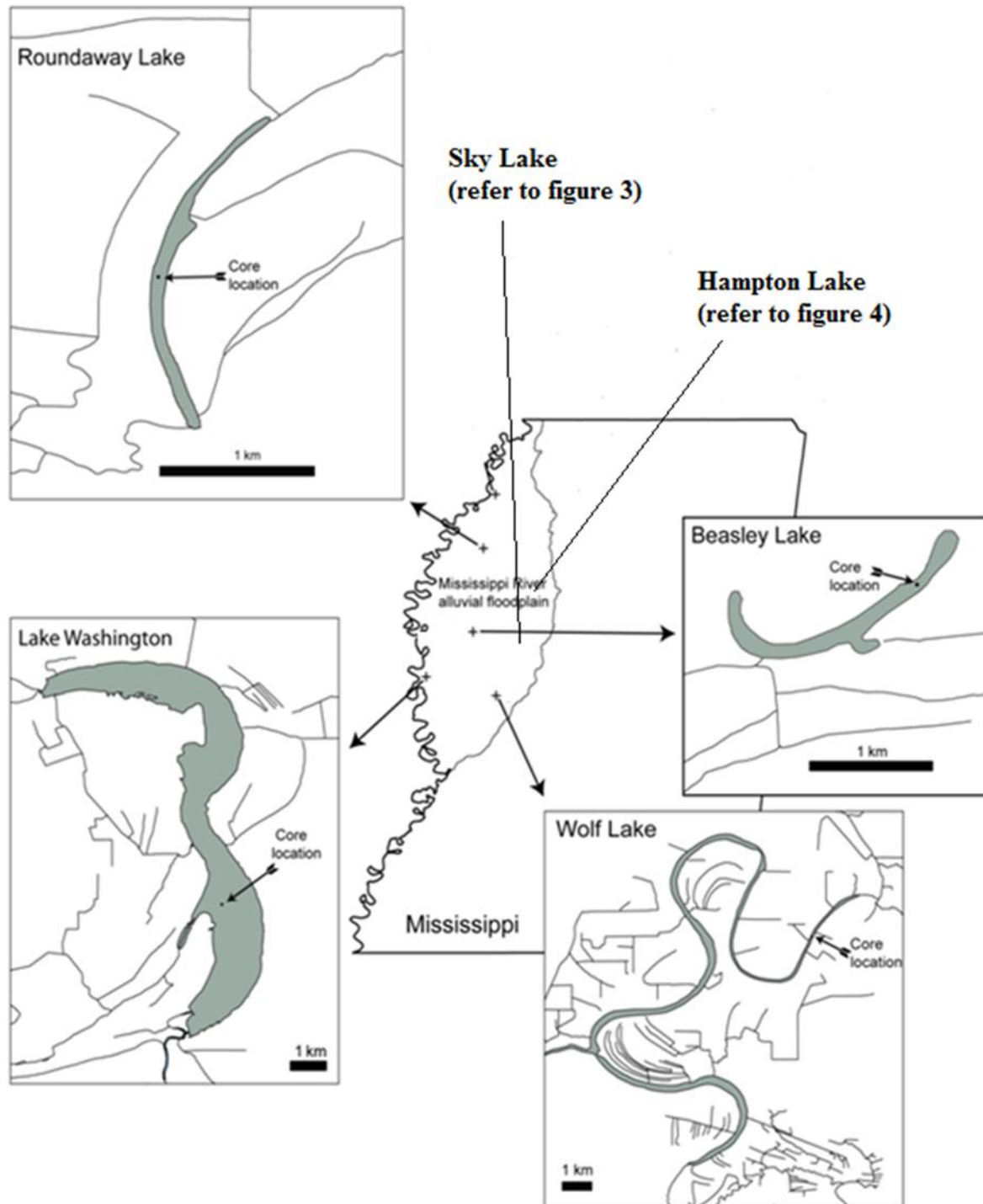


Figure 1. Locations of Oxbow Lakes in this study [adapted with permission from ref. 2]

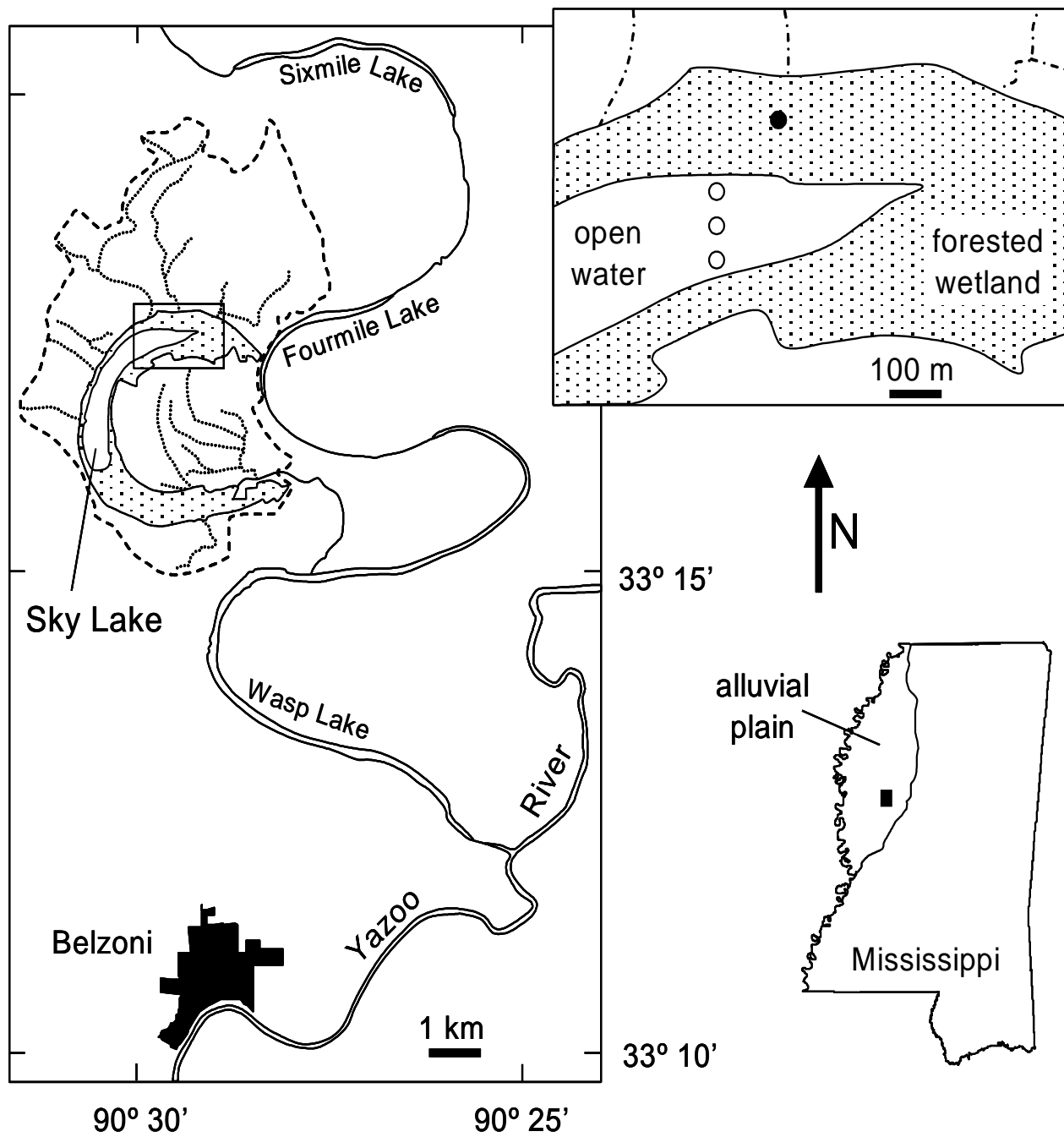


Figure 2. Sky Lake watershed shown in dashed lines. 1mm cores were sampled from middle circle [ref. 1].

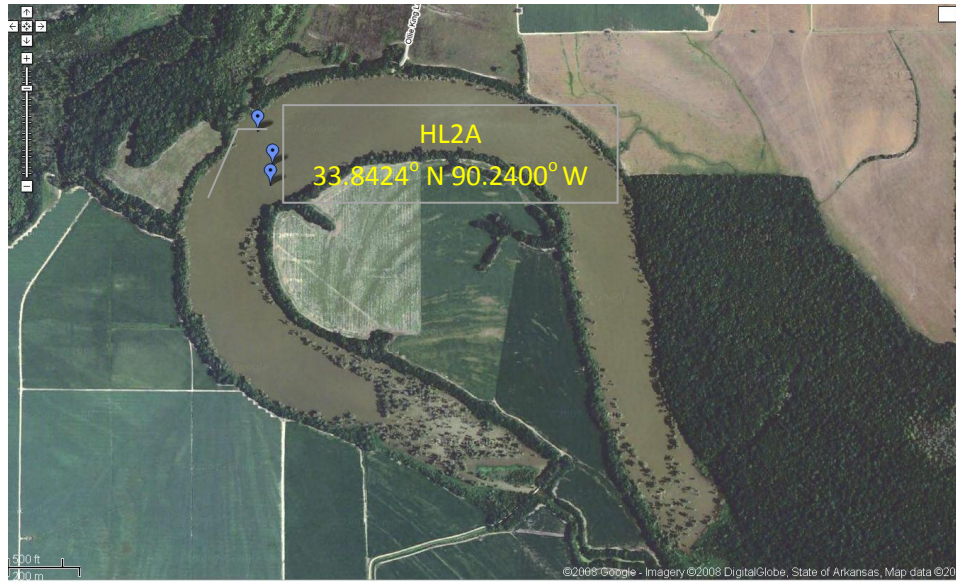


Figure 3. Core Location shown for Hampton Lake [3]



Figure 4. Sky Lake sediment core (SL5) being sliced into 1cm intervals at the National Sedimentation Laboratory.

PLUTONIUM

INTRODUCTION

Artificial radionuclides like ^{239}Pu and ^{240}Pu are introduced into the environment due to accidental releases from the nuclear power plants and testing of nuclear weapons. ^{239}Pu and ^{240}Pu are the most abundant isotopes of plutonium [4]. Their fallout records are preserved in the sediment and they are used to determine chronology for sediments; peak concentrations in sediments correspond to the year 1963 [5]. Years since 1963 divided by the depth yields average sedimentation rate (figure 5). The stratospheric fallout ratio is $^{240}\text{Pu}/^{239}\text{Pu} = 0.180 \pm 0.014$ and the Nevada Test Site fallout ratio is $^{240}\text{Pu}/^{239}\text{Pu} = 0.03 \pm 0.07$. Using these ratios one can decipher the source of fallout in a region.

Conventionally, radiometric analyses of ^{239}Pu and ^{240}Pu have been performed by alpha spectrometry. Alpha spectrometry is destructive, requires the use of large sample volumes and involves a lot of sample preparation. Further, alpha spectrometry cannot categorize ^{239}Pu and ^{240}Pu separately due to small difference in their alpha particle energies [6]. A potential alternative to using radiochemistry is the use of mass spectrometry. ICPMS has a number of advantages for long-lived radionuclides because it counts atoms instead of decays. It is suitable for routine analysis of large number of samples and can measure isotope ratios.

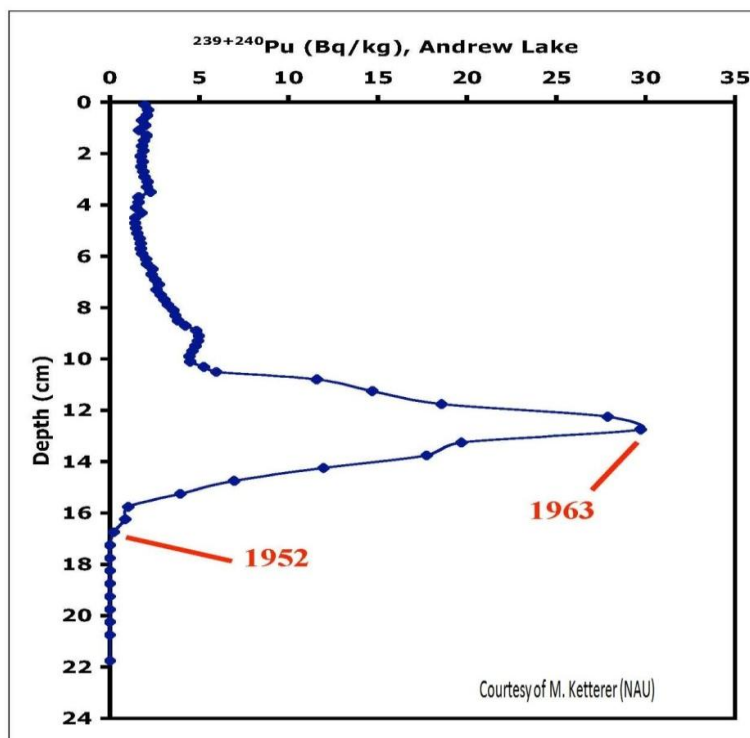


Figure 5. Example of use of Pu for age-dating sediments. Depth vs. $^{239+240}\text{Pu}$ activity (Bq/g) in Andrew Lake sediments [7].

OBJECTIVES

- To transfer and optimize analytical protocols to measure “fallout” plutonium (Pu) in sediments using Sector Field ICPMS.
- Use ICPMS to measure Pu activity and atom ratios in sediment cores from Oxbow Lakes in the Mississippi Delta to age-date the sediment.
- Compare sediment core age-dating results for Pu with that for conventional radioanalytical analysis of ^{137}Cs and ^{210}Pb .
- Determine the source(s) of Pu in the sediment using Pu isotopic signatures.

METHODS

PLUTONIUM EXTRACTION, ISOLATION AND CONCENTRATION

Sediment core samples from Washington Lake (WL1A) and Beasley Lake (BL1A) were analyzed for ^{239}Pu , ^{240}Pu and ^{242}Pu isotopes. The sample weights used for BL1A and WL1A cores ranged from 1.7 to 2.5 grams and 4.5 to 5 grams respectively. The samples were weighed into a 20ml glass vial and dry ashed at 600°C for 6 hours to remove organic matter. 50 pg of ^{242}Pu (NIST 4334g) was added as a spike for isotope dilution analysis. Five milliliters of 16M HNO_3 was added and the mixture was leached at 80°C for 16 hours. The samples were filtered using vacuum filtration and filters of mesh size 0.45 microns. The filters were rinsed with 15ml of de-ionized water and the rinsing solution was combined with the filtrate. Twenty milligrams of ascorbic acid were added to the solution for the conversion of all the Pu (III) to Pu (IV). The solution is kept as such for 1 hour for the complete conversion of Pu (III) to Pu (IV). The molarity of this solution is 4. TEVA Resin columns were prepared using 5ml pipettes and TEVA Resin powder. The narrow end of the 5ml pipettes were clogged with glass wool and 0.1 – 0.2gm TEVA Resin powder was added. The columns were conditioned by passing 5ml of 4M HNO_3 . 5ml of the sample solution were flushed through the column. During this step, Pu (IV) along with Np, Th and U is retained within the columns and other matrix elements are discarded. The columns were rinsed with 3ml of 4M HNO_3 and 5ml of 1M HNO_3 . The left over sample solution was loaded into the column in 5ml aliquots each time followed by rinsing with 3ml of HNO_3 and 5ml of 1M HNO_3 . The rinse step with 1M HNO_3 allows wash out of the majority of the U from the column. A final rinse of the column with 20 ml of 9M HCl was performed to wash out Th. Pu was eluted using 10ml of 0.02M HCl .

COLUMN CHEMISTRY

The functional group in the TEVA Resin that extracts Pu from sample solutions is a quarternary ammonium salt (figure 6) [8].

Trialkyl, methylammonium
nitrate (or chloride)

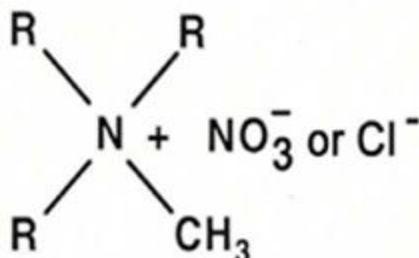
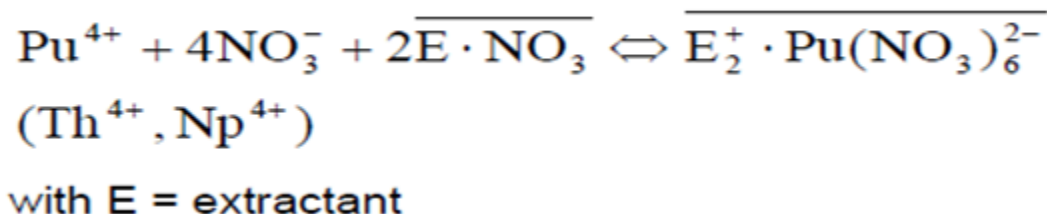


Figure 6. TEVA Resin Quarternary Ammonium Salt [8]

The assumed extraction equilibrium is as follows [8]:



In aqueous solutions, Pu can exist in Pu(III), Pu(IV), Pu(V), Pu(VI) and Pu(VII) oxidation states simultaneously [9]. Pu(III) and Pu(IV) are in general believed to be relatively insoluble in solutions compared to Pu(V) and Pu(VI) which are considered to be more soluble [9]. It has been reported that in 7M HNO₃ solution, Pu(IV) can exist as a complex mixture of Pu(NO₃)₂²⁺, Pu(NO₃)₄, and Pu(NO₃)₆²⁻ [9].

Figure 7 presents the elution profiles of different radionuclides in HNO₃ and HCl. Pu(IV) shows maximum retention within 2M-4M HNO₃. In this range U(VI) tends to elute. When the samples are loaded on the TEVA Resin from 4M HNO₃, Pu(IV) is retained. Th, which can interfere with Pu analysis, maybe eluted with 6M HCl [8].

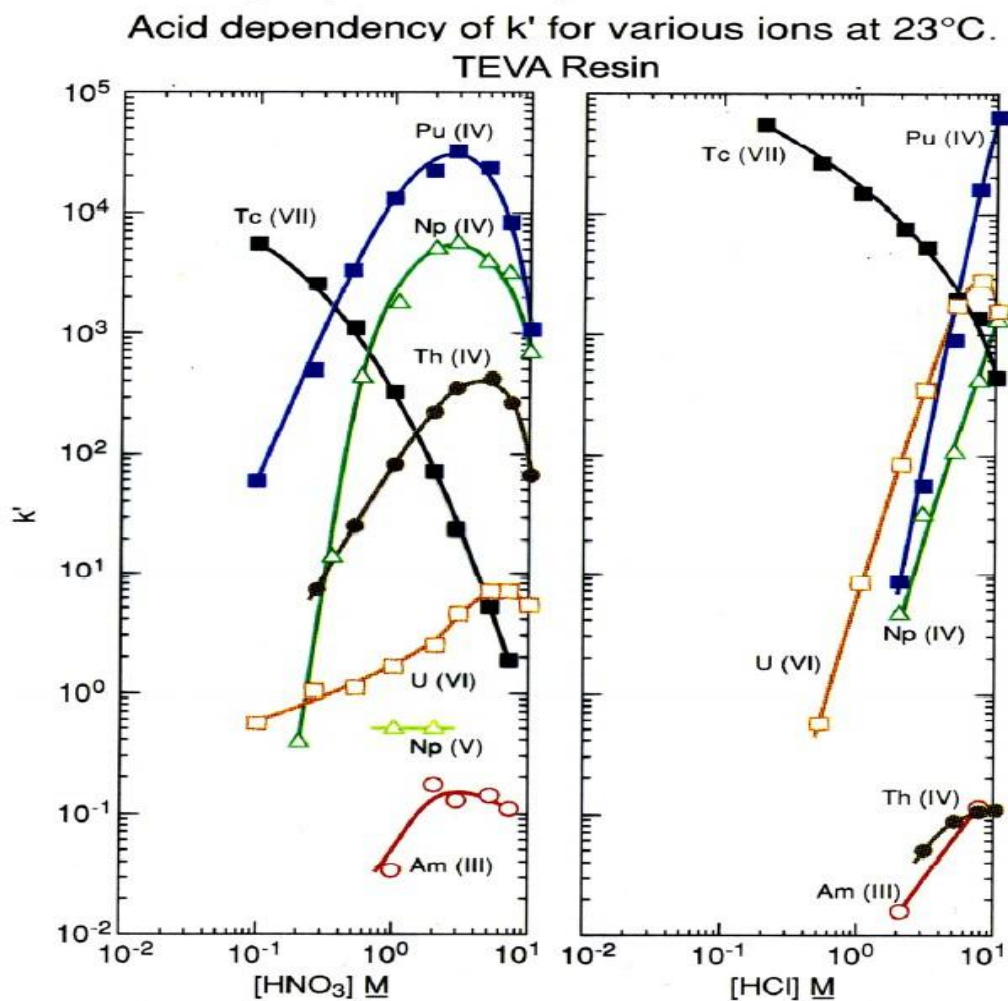


Figure 7. TEVA Resin Elution profiles in HNO_3 and HCl solutions [8].

Figure 8. Sample preparation for Pu analysis.

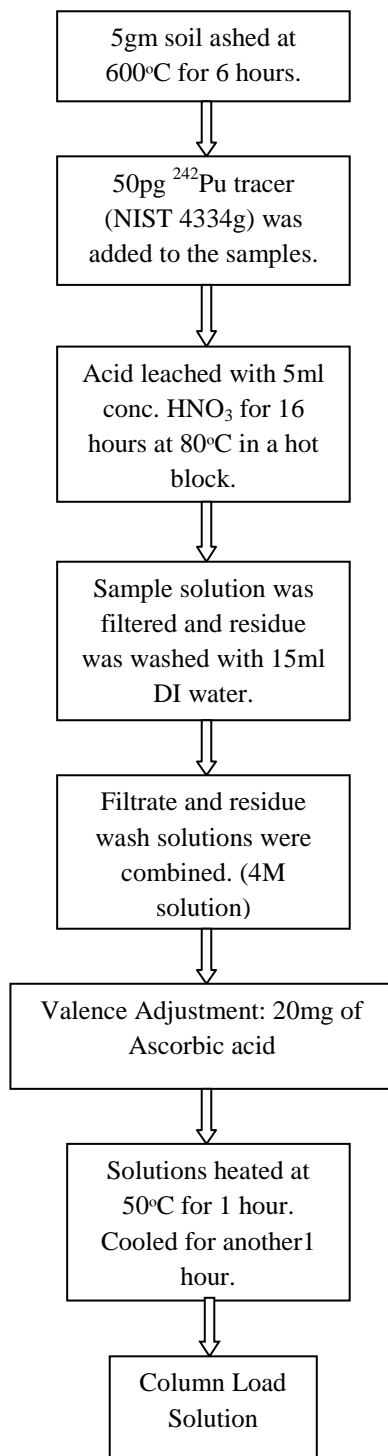
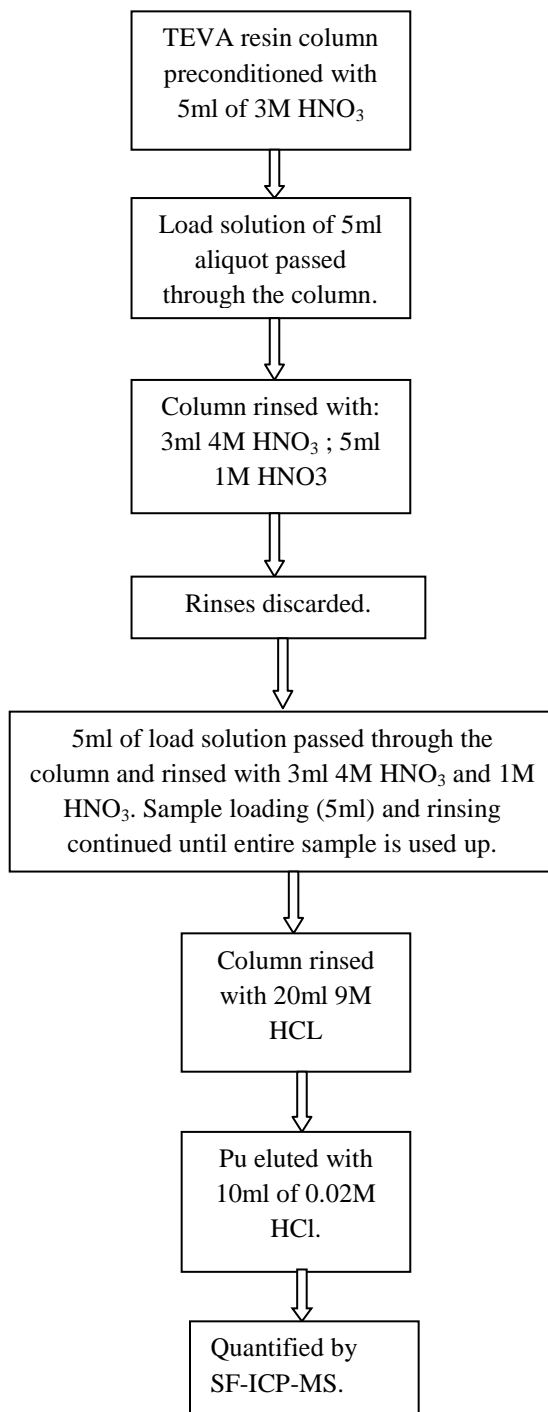


Figure 9. Column Chemistry for Pu isotope separation



MEASURING PLUTONIUM ISOTOPES BY ICPMS

Sample handling preparation of standards and reagents were performed in clean rooms under laminar flow clean air benches to minimize the risk of contamination. All ICP-MS measurements were carried out using an Element XR (Thermo Fisher), figure 10. For measuring Pu isotopes, a high efficiency sample introduction system APEX desolvation unit was utilized to minimize hydride formation. SF-ICP-MS operating conditions are summarized in table 2. Use of SF-ICP-MS provides good accuracy and precision and detection limits within femtogram levels. The main issues associated with the determination of Pu isotopes are the following:

- a) Formation of $^{238}\text{U}^1\text{H}$, $^{238}\text{U}^1\text{H}^1\text{H}$ that cause interferences with ^{239}Pu and ^{240}Pu [5].
- b) Tailing effect of ^{238}U on the ^{239}Pu signal [6].

Uranium ideally should be removed from the sample solutions during resin treatment and before analysis as resolution of $^{238}\text{U}^1\text{H}$ is not possible using SF-ICP-MS [5].

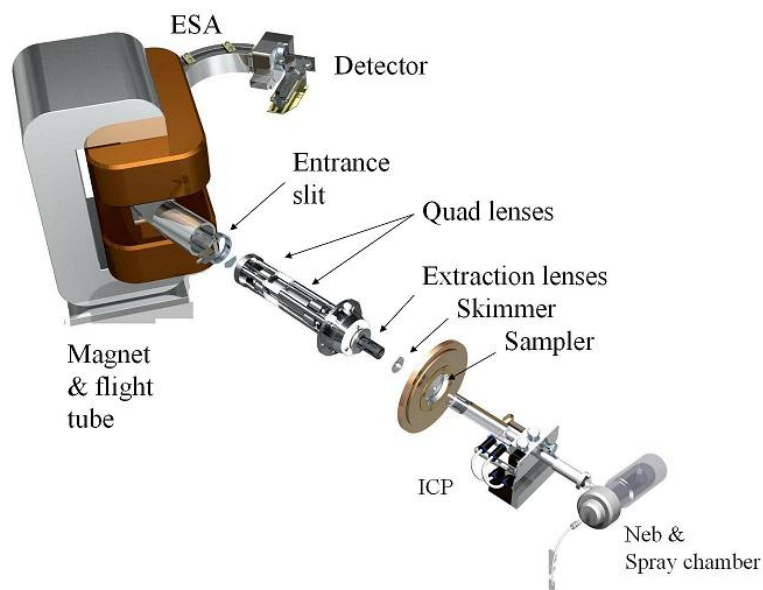


Figure 10. Schematic of Sector Field Inductively Coupled Plasma mass Spectrometry [10].

Table 2. Operating Conditions of the SF-ICP-MS.

Parameter		Operating Condition
Forward Power		1450
Cool gas flow rate		16 L/min
Auxiliary gas flow rate		1.0 L/min
Sample gas flow rate		1.2 L/min
Mass Window		20
Scan type		Escan
Integration window		80
Samples/peak	^{239}Pu	150
	^{240}Pu	150
	^{242}Pu	50
Dwell time	^{239}Pu	0.1s
	^{240}Pu	0.1s
	^{242}Pu	0.01s

RESULTS AND DISCUSSION

Table 3 shows the results for the determination of ^{239}Pu , ^{240}Pu concentration, $^{239+240}\text{Pu}$ activity and $^{240}\text{Pu}/^{239}\text{Pu}$ atom ratio for Beasley lake open water core. ^{241}Pu was too low in concentration to accurately measure and will not be reported here. In some cases, concentrations of Pu determined by ICPMS were converted to activities using the specific activity of the isotope. The results for Washington and Roundaway lakes wetland core are presented in tables 8 and 9 (appendix). Of the cores analyzed the Beasley Lake open water core has the best defined chronology [1]. The lake was recently found to show a reduction in sediment accumulation rates due to erosion control and cropping practices [1]. We analyzed sediment samples using both batch (resin beads mixed with the solution) and column methods. Whereas Pu levels were found to be lower in the batch method, trends for both were similar (figure 11). The peak Pu depth was in agreement with peak ^{137}Cs depth. Usually these peaks correspond to 1963, the peak year for fallout, but the ^{210}Pb dating places them a few years later. It is possible that the recent changes in sedimentation rates affected that determination. In any case, the profiles show Pu peaks in general agreement with the conventional dating methods. A core a greater number of samples (from Sky Lake) was also prepared for analysis with the hope of demonstrating an even better resolved peak profile, however due to instrument repair the samples were not analyzed by the time this report was completed.

$^{240}\text{Pu}/^{239}\text{Pu}$ atom ratios averaged 0.177, consistent with a global fallout source. The Pu activity profile for Washington and Roundaway Lakes are shown in figures 12 and 13. The data suggests that these sediments were, to some extent, mixed since deposition. This agrees with conventional dating results which also showed data scatter indicative of mixing [1]. Interestingly,

for Washington Lake the peak Pu level occurred at a depth of ~21 cm which is similar to the peak depth for ^{137}Cs (18 cm, not shown). In retrospect, these wetland cores were not the best choice for testing; but they do show that the method is useful for identifying cores that have uncharacteristic global fallout profiles, which in turn suggests that the core has been mixed and may not be the best choice for costly ^{210}Pb dating.

Table 3. Pu Summary for Beasley Lake.

Year	Depth(cm)	$^{239}\text{Pu}(\text{pg/g})$		$^{240}\text{Pu}(\text{pg/g})$		$^{240}\text{Pu}/^{239}\text{Pu}$		$^{239+240}\text{Pu}(\text{Bq/kg})$	
		column	batch	column	batch	column	batch	column	batch
2003	6	0.94	0.10	0.18	0.02	0.19	0.21	3.65	0.39
1992	16	1.04	0.17	0.18	0.03	0.17	0.18	3.89	0.63
1982	23	1.51	0.13	0.24	0.03	0.16	0.20	5.49	0.50
1971	47	2.72	1.07	0.42	0.25	0.16	0.23	9.82	4.55
1966	60	2.41	0.31	0.46	0.06	0.19	0.21	9.43	1.25
1963	68	0.06	0.06	0.02	0.01	0.25	0.25	0.27	0.24
1953	90	1.69	0.43	0.30	0.09	0.18	0.21	6.43	1.74
Avg		1.48	0.32	0.26	0.07	0.19	0.21	5.57	1.33
SD		0.91	0.36	0.15	0.08	0.03	0.02	3.37	1.52

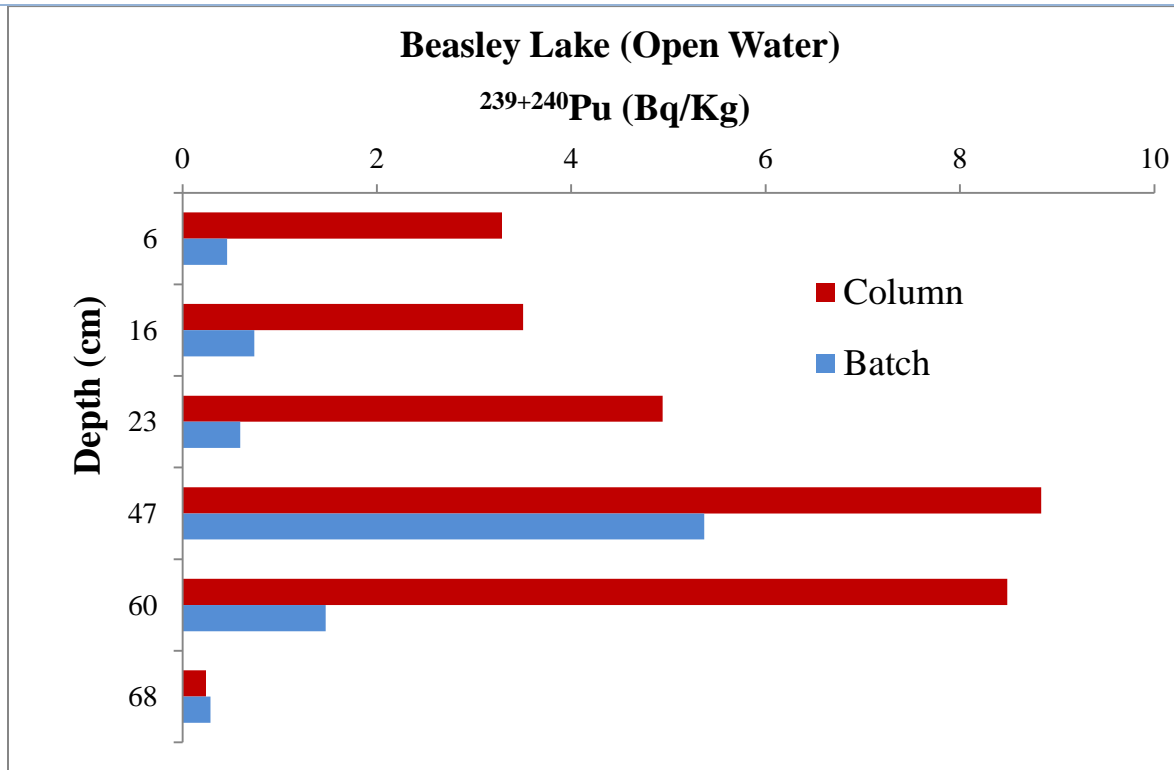


Figure 11. Depth vs. $^{239+240}\text{Pu}$ activity for Beasley Lake

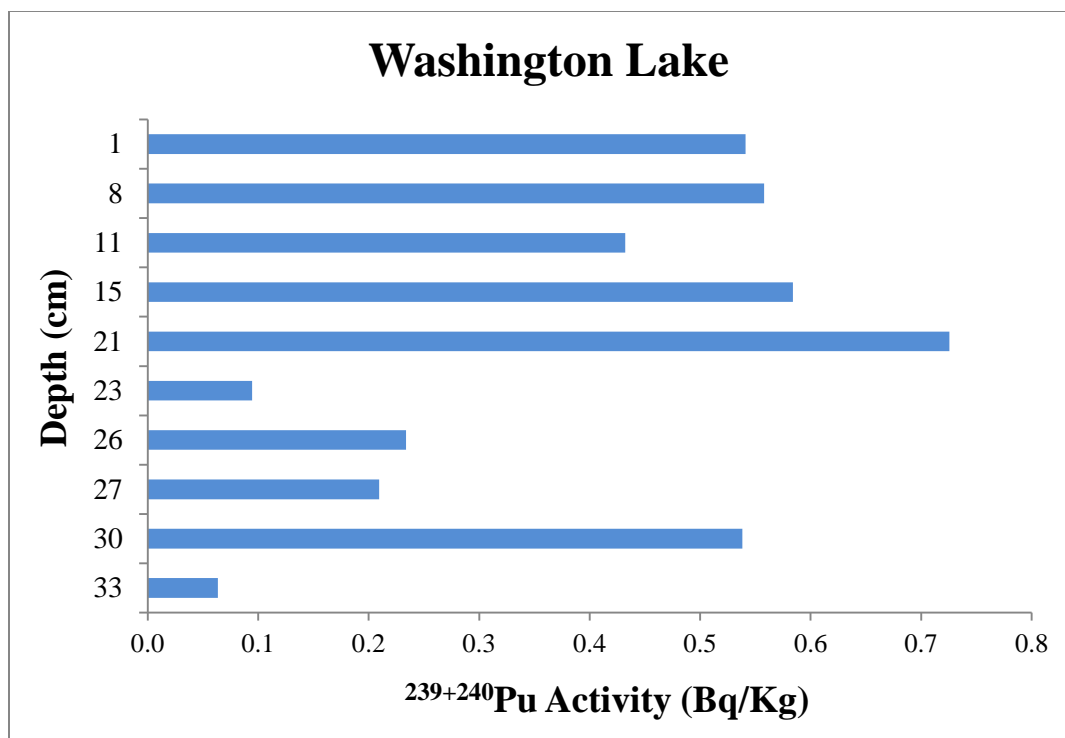


Figure 12. Depth vs. ²³⁹⁺²⁴⁰Pu activity for Washington Lake

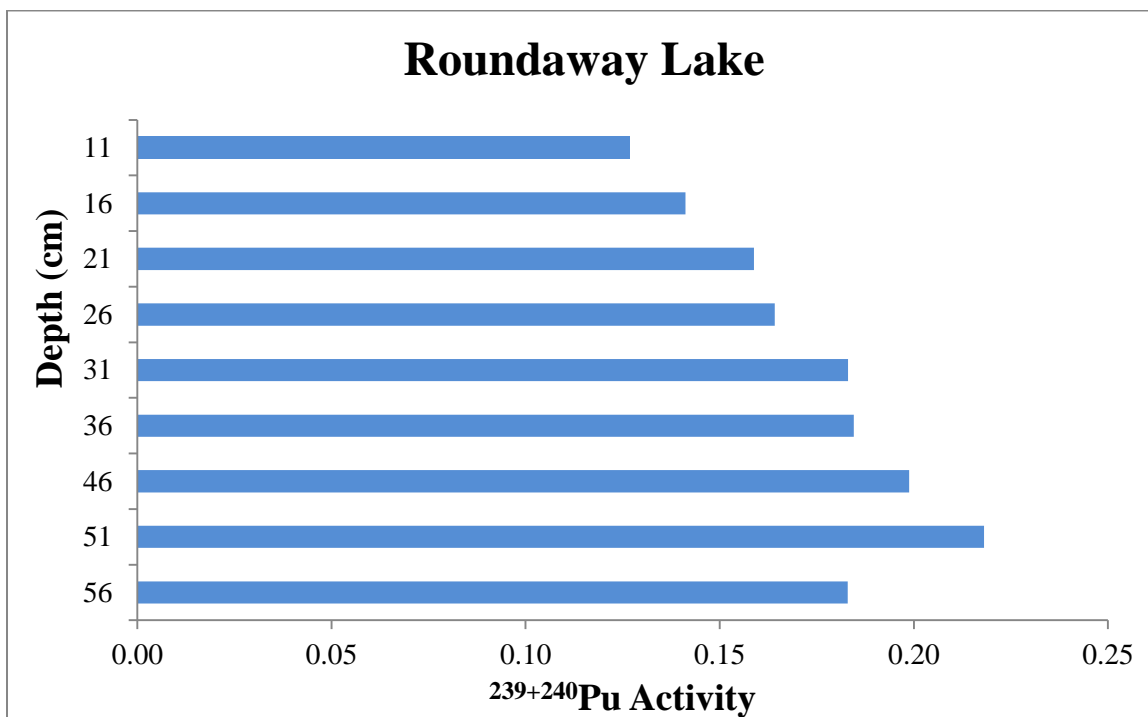


Figure 13. Depth vs. ²³⁹⁺²⁴⁰Pu activity (Bq/kg) for Roundaway Lake

LEAD

INTRODUCTION

LEAD IN SEDIMENTS

Pb has been mined and used by humans for several thousand years [11]. Deposits of Pb have characteristic isotopic composition [11]. Analyzing stable Pb isotopes (^{206}Pb , ^{207}Pb and ^{208}Pb) and identifying the ratios ($^{206}\text{Pb}/^{207}\text{Pb}$ and $^{208}\text{Pb}/^{207}\text{Pb}$) can help in the determination of point sources of Pb contamination. Two well-known sources of Pb contamination are usage of leaded gasoline (~1924 – ~1960) and coal mining [11].

AGE-DATING OF SEDIMENTS USING ^{210}Pb

Sediments are dated to determine the spatial and temporal patterns of metal deposition in an area, to determine the effectiveness of erosion control methods (figure 14 and 15), to manage reservoirs more effectively and ultimately to calculate the rates of sediment accumulation. Dating of sediments is done by using natural radio nuclides like ^{210}Pb and ^{14}C and artificial radio nuclides like ^{137}Cs , ^{239}Pu and ^{240}Pu . ^{210}Pb is a member of the ^{238}U decay series. Half life of ^{210}Pb is 22 years. The content of ‘supported’ ^{210}Pb in soils is produced by the decay of ^{226}Ra . ^{222}Rn diffuses from the soil surface and decays in the atmosphere (figure 16). This results in the deposition of ‘unsupported’ or ‘excess’ ^{210}Pb combined with aerosol and moisture on the soil surface. ^{210}Pb dating method is based on measuring and comparing the quantities of supported and unsupported ^{210}Pb . However there are two major limitations in applying this method. Firstly, mixing or displacement of sediment particles gives erroneous dates and secondly this method does not hold good for sediments more than 100 years old as no excess ^{210}Pb can be detected beyond the background level. ^{210}Pb decays by emitting beta particles of energy 17 kev and 63.5 kev and gamma rays of energy 46.5kev [12]. The decay products are ^{210}Bi and ^{210}Po respectively.

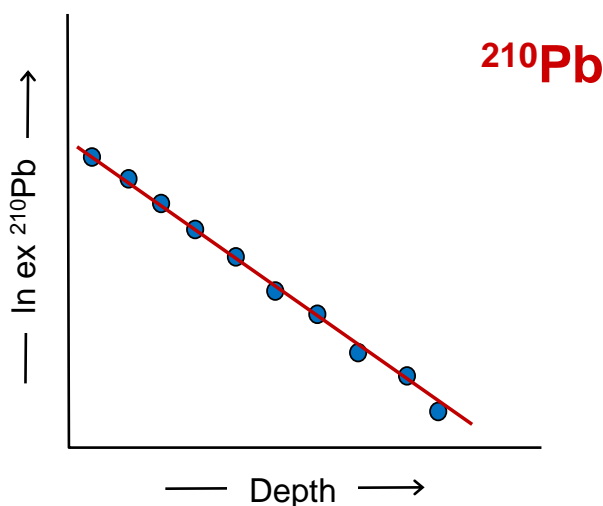


Figure 14. Plot of ^{210}Pb activity (dpm/g) vs. depth in absence of an erosion control measure. Higher activity is seen at lower depths meaning more sedimentation [13].

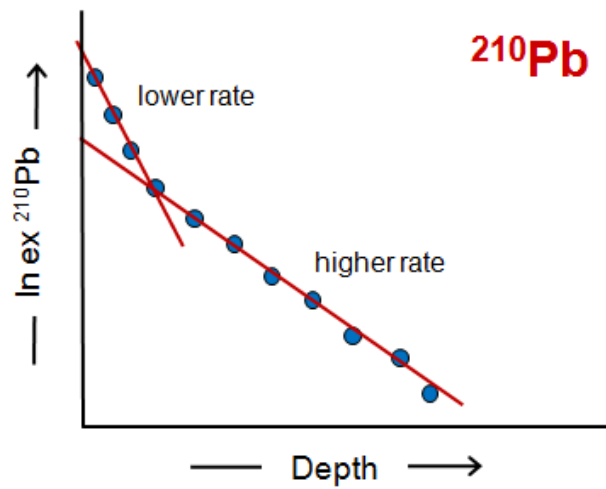


Figure 15. Plot of ^{210}Pb activity vs. depth after an erosion control structure is introduced [13].

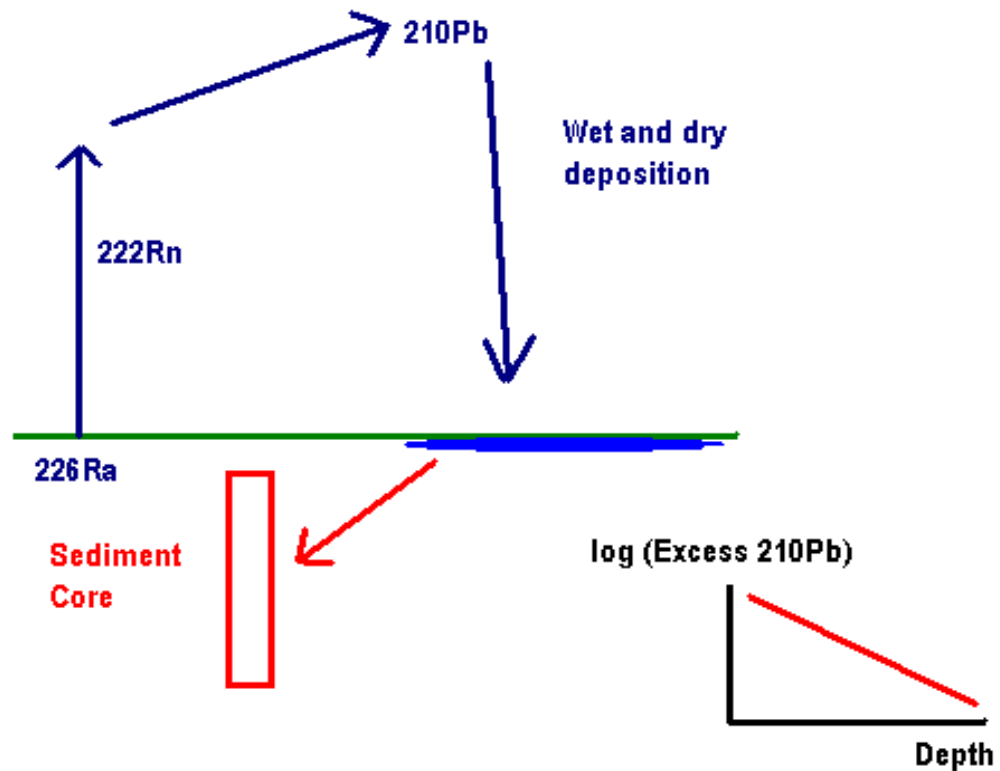


Figure 16. Upward diffusion of ^{222}Rn and subsequent deposition of ^{210}Pb (excess) on the sediment surface [7].

OBJECTIVES

- Determine the feasibility of using ICPMS for ^{210}Pb age-dating of sediments
- Analyze total-Pb in the sediment cores and determine changes with time (depth).
- Determine Pb isotopic ratios in open water and wetland cores to see if they can be used to determine the source(s) of lead in Hampton and Washington lakes.

METHODS

Wetland and open water sediment core samples from Lake Washington (WL1A and WL2 respectively) and open water sediment samples from Hampton Lake (HL2A) were subjected to total Pb and Pb isotopes (^{206}Pb , ^{207}Pb , ^{208}Pb and ^{210}Pb) analysis.

SAMPLE PREPARATION FOR TOTAL Pb ANALYSIS

Two grams of each sediment sample was weighed in a 20 ml glass vial and ashed in a muffle furnace at 600°C for 6 hours. The ashed samples were transferred to already cleaned 50ml tubes and leached with 20ml of concentrated HNO_3 for 8 hours in a hot block. The leached samples were filtered using filters of mesh size 0.45 microns and the leach-ate volume was made to 50ml with de-ionized water. 0.5ml liquid from the diluted leach-ate was transferred to 15ml clean centrifuge tubes and the volume was made up to 10ml with 2% HNO_3 . Sample preparation process is summarized in figure 17.

SAMPLE PREPARATION FOR LEAD ISOTOPE (^{206}Pb , ^{207}Pb , ^{208}Pb , ^{210}Pb) ANALYSIS

Two grams of each sediment sample was weighed in a 20 ml glass vial and ashed in a muffle furnace at 600 °C for 6 hours. The ashed samples were transferred to already cleaned 50ml tubes and leached with 20ml of concentrated HNO_3 for 8 hours in a hot block. The leached samples were filtered using vacuum filtration with filters of mesh size 0.45 microns and the leach-ate volume was made to 50ml with de-ionized water. 0.5ml liquid from the diluted leach-ate was used for total Pb analysis. The remaining 49.5 ml liquid was heated to complete dryness in a hot block. The volumes of the samples were made up to 10ml using 1M HNO_3 . Pb resin columns were prepared by clogging the narrow end of 5000 μl pipette tips with glass wool and filling it up with 0.1 - 0.2gm of Pb resin powder (100 - 150 μm). The columns were conditioned by passing 5ml of 1M HNO_3 . The sample solutions were then loaded on to the columns and the eluent was discarded. The columns were washed using 20ml of 1M HNO_3 . This wash is performed to remove Bi and Fe if present. The eluent was discarded. 10ml of 0.1M HNO_3 was added to the columns to remove any ^{210}Po if present. Following the last wash, 40ml of 0.1M citric acid monohydrate solution was added to the columns and the eluent was collected in 50 ml centrifuge tubes. The solutions were heated to complete dryness in a hot block and the volumes were raised to 10ml with 1% HNO_3 . The sample solutions and two method blanks were then analyzed for ^{206}Pb , ^{207}Pb , ^{208}Pb and ^{210}Pb using Element XR. Sample preparation and column chemistry processes are summarized in figures 17 and 18. It should be noted that a Pb-isotope reference material (NIST 981) was included in the analyses.

Figure 17. Sample Preparation for Pb analysis

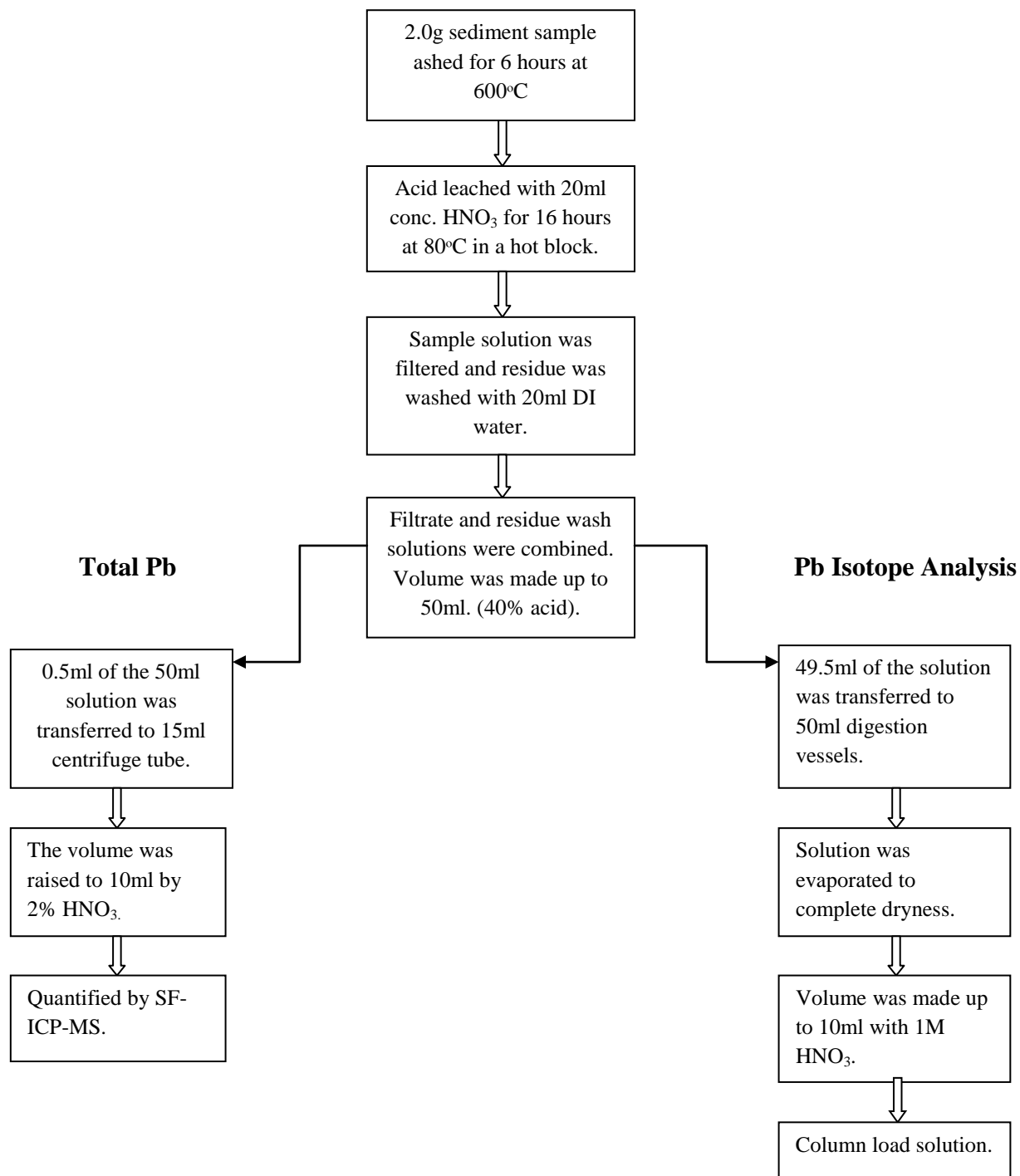
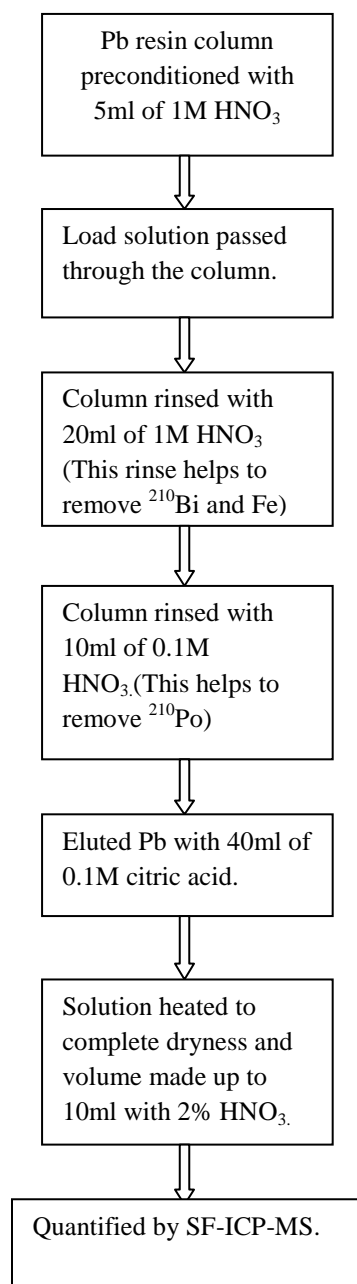


Figure 18. Column Chemistry for Pb isotope separation.



COLUMN CHEMISTRY

The extractant in Pb resin 4,4''(5)-di-*t*-butylcyclohexano 18-crown-6 in isodecanol (figure 19). Figures 20 and 21 show the uptake of Pb with monovalent and divalent metal ions respectively. The retention capacity (k') of Pb is higher than 100 in nitric acid concentrations ranging from 0.1M to 10M [24].

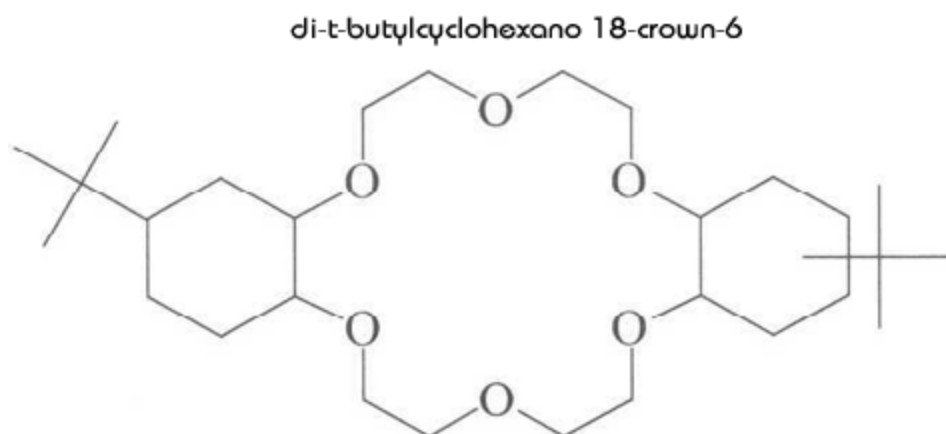
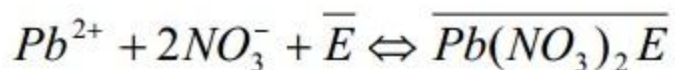


Figure 19. 4,4''(5)-di-*t*-butylcyclohexano 18-crown-6 in isodecanol [24]

The assumed extraction equilibrium is as follows [24]:



with E = crown ether.

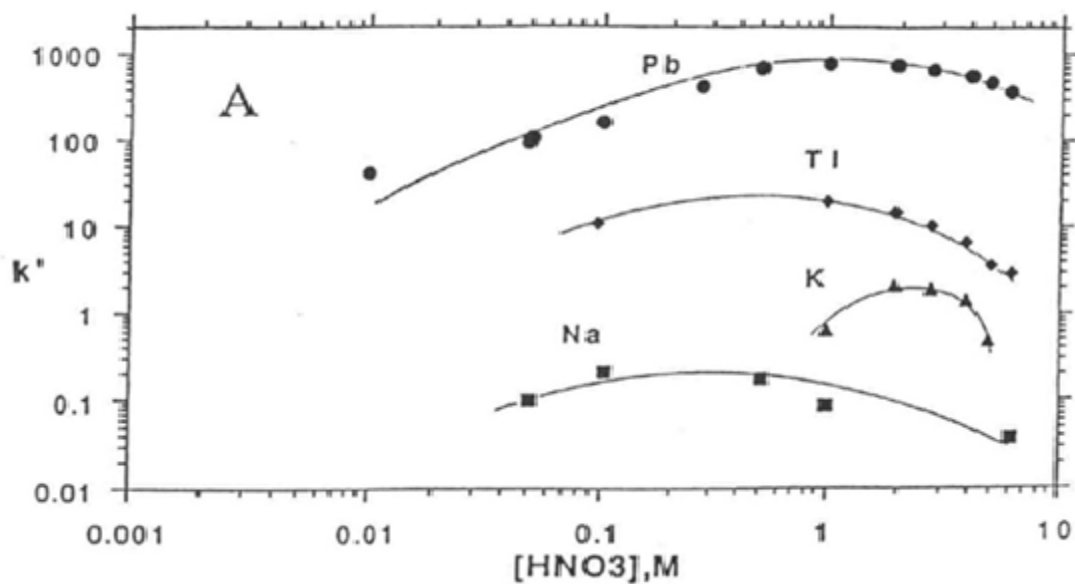


Figure 20. Nitric acid dependency of selected monovalent metals on Pb resin [24].

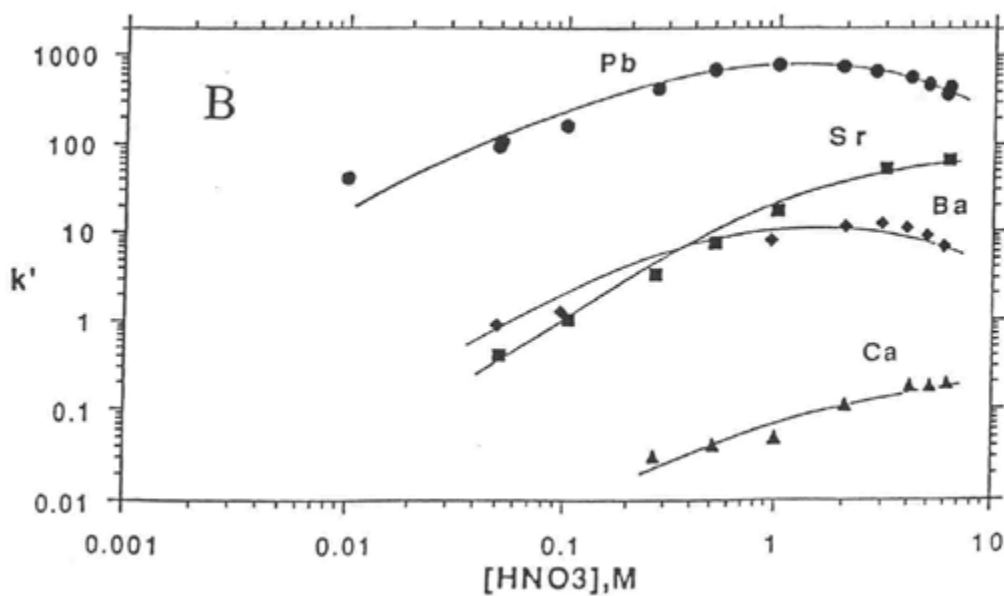


Figure 21. Nitric acid dependency of selected divalent metals on Pb resin [24].

ICPMS Analysis

Sample handling preparation of standards and reagents were performed in clean rooms under laminar flow clean air benches to minimize the risk of contamination. All ICP-MS measurements were carried out using an Element XR (Thermo Fisher), figure 20. For total Pb and isotopic measurements (^{206}Pb , ^{207}Pb , ^{208}Pb and ^{210}Pb), a high efficiency sample introduction system APEX Q desolvation unit was utilized to minimize hydride formation. SF-ICP-MS operating conditions are summarized in table 4. Use of SF-ICP-MS provides good accuracy and precision and detection limits within femtogram levels.

The common polyatomic interferences in the detection of ^{210}Pb are the following:

- Formation of a massive peak at mass 208. This peak tails to the adjacent masses 209 and 210. This is from the ions losing energy by collisions with residual gas molecules in the analyzer [25].
- Formation of $^{208}\text{Pb}^1\text{H}^1\text{H}$. Since separation of stable and radioactive isotopes using chromatographic resins is impossible, the solution to this could be through hydrogen removal [25].

Table 4. Operating Conditions of the SF-ICP-MS

Parameter	Operating Condition
Forward Power	1450
Cool gas flow rate	16 L/min
Auxiliary gas flow rate	1.0 L/min
Sample gas flow rate	1.2 L/min
Mass Window	5
Scan type	Escan
Integration window	5
Samples/peak	100
Dwell time	0.05s

RESULTS AND DISCUSSION

Total-Pb: The average lead concentrations and lead isotopic compositions of Washington Lake (WL1A and WL2) cores and Hampton Lake (HL2A) cores are given in table 5. Detailed Pb concentrations for the cores (WL1A, WL2, HL2A) are presented in the appendix (tables 9 and 10). Total Pb concentrations ranged from about 4-12 ppm in all the three sediment cores, which is slightly below the natural Pb content in soil [26]. The variation in total-Pb concentration with depth (time) for HL is presented in figure 21; the WL cores are not shown because chronology suggests that they were mixed since deposition. The concentration rises from about 6 ppm during the early part of last century to ~12 ppm during the 1950's and early 1960's, a time when leaded gasoline use was relatively high, then diminishes to ~7 ppm in the most recent (surface) sediment. The 6 ppm concentration likely reflects the background levels

from naturally-occurring lead. Nevertheless, this profile should be viewed with caution until a more detailed profile with greater resolution (more samples) is determined.

Table 5. Mean Pb Concentration and Pb Isotopic compositions in Washington and Hampton Lakes.

Oxbow Lake ID	Total-Pb (ppm)	$^{208}\text{Pb}/^{207}\text{Pb}$	$^{206}\text{Pb}/^{207}\text{Pb}$	$^{208}\text{Pb}/^{206}\text{Pb}$	$^{207}\text{Pb}/^{206}\text{Pb}$	^{210}Pb (cps)
WL1A	7.86	2.49	1.22	2.02	0.81	294
WL2	4.03	2.47	1.22	2.03	0.82	219
HL2A	8.48	2.48	1.22	2.03	0.82	400

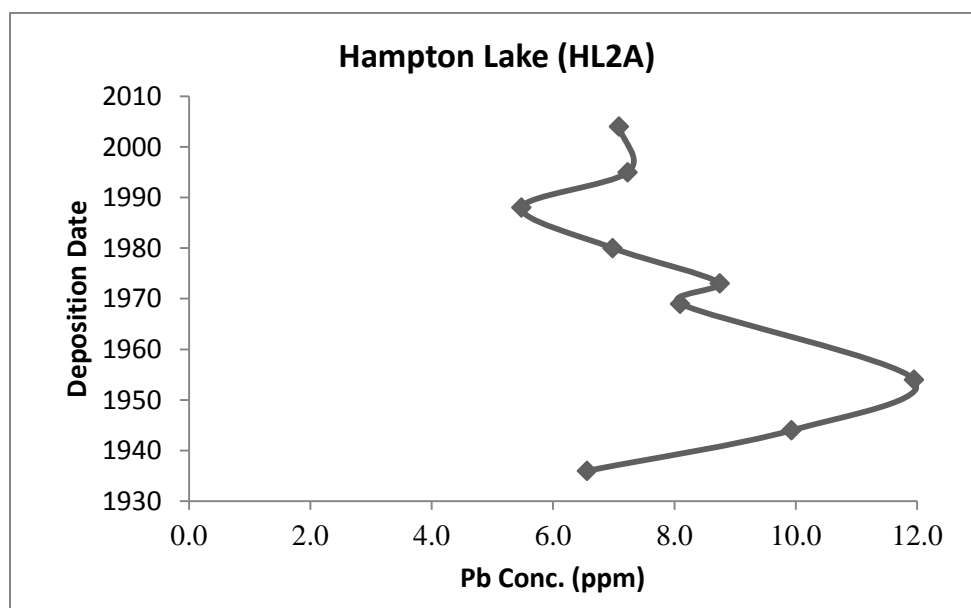


Figure 22. Deposition date vs. Pb conc. in Hampton Lake

LEAD ISOTOPES: Lead isotopes are the products of radioactive decay of other isotopes. Their levels and distribution in a geologic sample depends in part upon the age and environmental conditions of the source material. Isotopes of Pb have long been used in fingerprinting sources of Pb contamination [27]. This can be accomplished using a two component mixing diagram (isotopic plot). A mixing diagram (figure 23) can be constructed by plotting two different ratios with common denominator of any two well established Pb sources.

Samples that plot along a mixing line comprise of mixtures of both the end members. Samples that deviate from the line indicate a different source.

Results for the three sediment cores (WL1A, WL2 and HL2A) are provided in the Appendix (Tables 9-10). Overall, the mean $^{207}\text{Pb}/^{206}\text{Pb}$ isotopic ratio was 0.82, and the mean $^{208}\text{Pb}/^{206}\text{Pb}$ ratio was 2.03. Replicate analysis of NIST 981 (~1.7 μg on column) resulted in a relative standard deviation (RSD) of 0.27 and 0.48 for 208/206 and 207/206, respectively. Experimentally established ratios differed from certified ratios by no more 0.42%. Data herein were not corrected for mass bias, which is expected to be smaller than the observed experimentally variability.

A mixing diagram was constructed based upon literature values, with “natural” Pb from mineral phases (e.g., iron oxides, aluminosilicates) in soil, American ores/leaded gasoline, and coal as possible end members (figure 24) [28, 29, 30, 31]. The lead isotopic signatures for the sediment samples generally fall on a straight line within the “natural” Pb region, but gasoline and coal can’t be ruled out. Data scattering around the line between the end members likely reflects variability in the analysis rather than additional sources with different isotopic signatures.

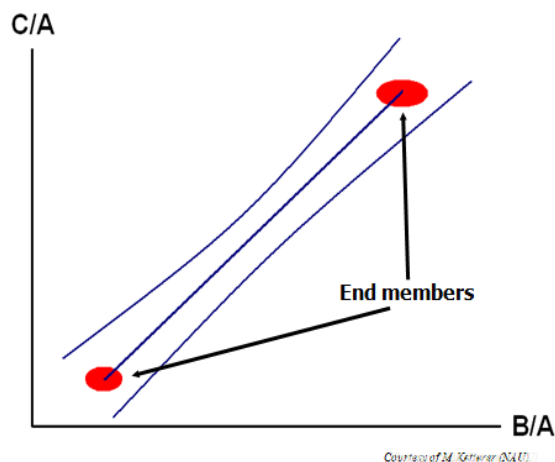
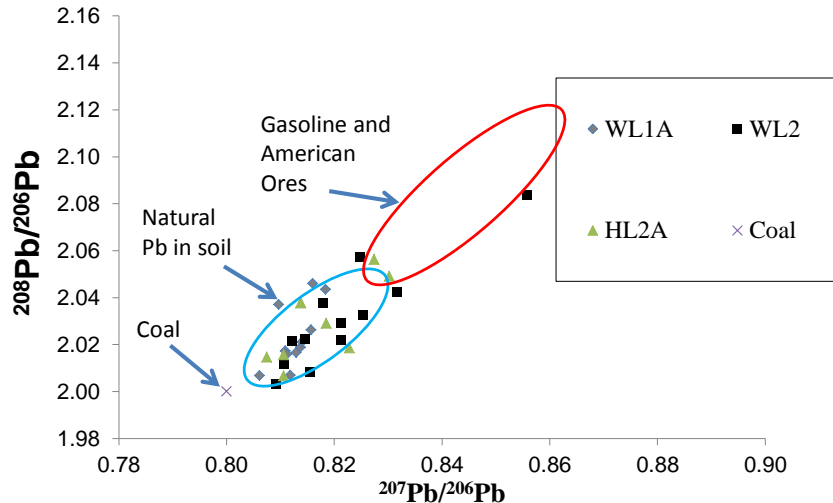


Figure 23. An example of two component mixing diagram [7].

Three isotope plot showing compositions of possible Pb sources



Oval regions generalized from Ettler et al. (2004) *Anal. Bioanal. Chem* 378:311-317⁴⁶

Figure 24. $^{208}\text{Pb}/^{206}\text{Pb}$ vs. $^{207}\text{Pb}/^{206}\text{Pb}$ mixing diagram for sediments from Hampton and Washington Lakes [11].

^{210}Pb : Determination of ^{210}Pb in the sediment samples by ICP-MS proved to be difficult. The levels of ^{210}Pb were expected to decrease with depth but instead we found a correlation with total Pb (figure 25) in Hampton Lake open water. This suggests that interference from stable Pb perhaps a $^{208}\text{PbHH}^+$ and /or the tail of the large ^{208}Pb (referred to as abundance sensitivity) peak is present. Because we were unable to mitigate these interferences using different instrumental parameters and sample introduction techniques, further study was stopped. Possible solutions to this problem include using a collision cell to minimize polyatomic interferences, and to increase sensitivity using the new jet-interface option for the ICPMS, which has been shown to enhance signal 100x.

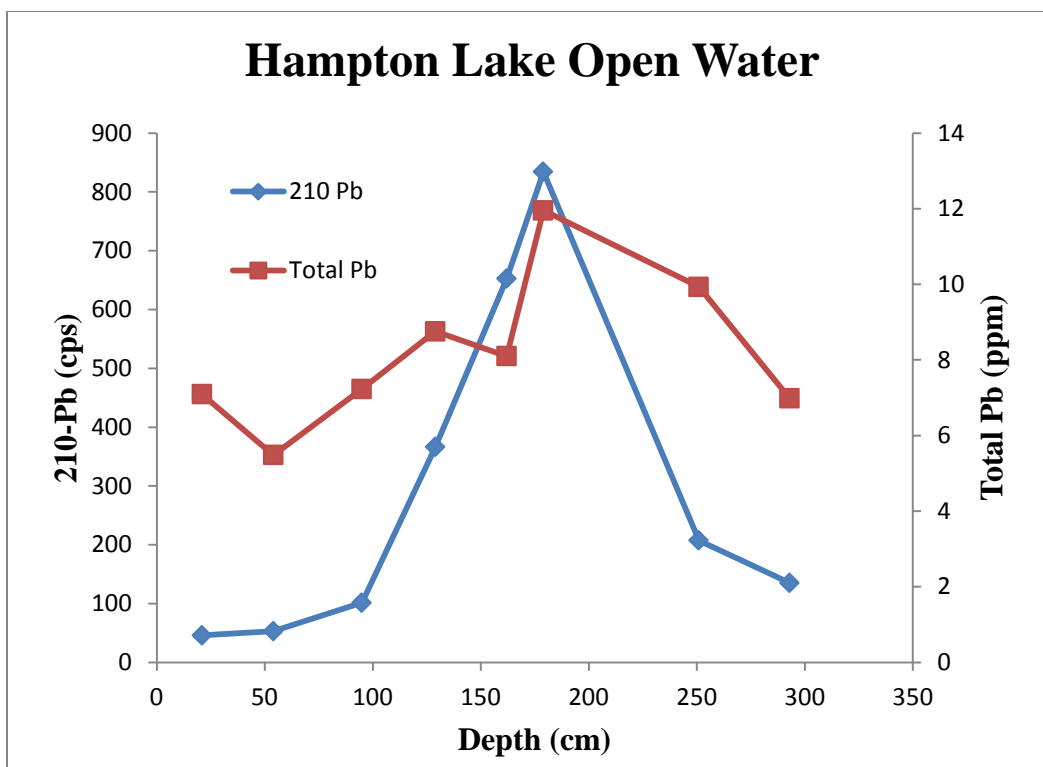


Figure 25. ^{210}Pb counts and total-Pb concentration versus depth (x axis).

SIGNIFICANT FINDINGS AND RECOMMENDATIONS

Analyses of an undisturbed core yielded a Pu peak at a depth which is in good agreement with conventional ^{137}Cs and ^{210}Pb dating. The column method yielded better recoveries compared to the batch method. Open water cores provided Pu profiles more conducive for dating compared to wetland cores; wetlands generally had lower sedimentation rates and appeared (sometimes) to have been mixed since deposition. It is recommended that future work utilize the column method and include more samples to obtain a higher resolution chronology. Overall, this study has demonstrated that ICPMS can serve a useful role in rapidly identifying sediments that have experienced a degree of mixing since deposition, and thus can be used as a screening tool, eliminating time-consuming and costly ^{210}Pb analyses on such cores. Moreover, because the methodology has now been established in our lab (there is a significant learning curve), we can provide Pu analyses with isotopic ratios when needed by the Mississippi water resources research community.

For lead, the analytical procedure developed in this work and detailed in this report allows total-Pb and Pb isotope (^{206}Pb , ^{207}Pb , ^{208}Pb) determinations at ppm levels in sediment samples using ICP-MS. Isotopic plots suggest that the Pb likely stems from natural sources, although both coal and leaded gasoline may provide a slight contribution. This study demonstrates that ICP-MS is a powerful tool for environmental studies using Pb ratios to detect different sources of Pb. Unfortunately, the results for ^{210}Pb by ICPMS were less promising. The counts at mass 210 were low and subject to interferences. Two approaches are suggested to overcome these issues: increase sensitivity (a new jet-interface option has been shown to enhance signal >100x), and remove polyatomic interferences using a collision cell.

Information transfer: Publications resulting from this work include a paper in the 2012 Mississippi Water Resource Conference Proceedings. This work also contributed toward a Master's thesis by Ms. Pragya Chakravarty titled "Elemental and Isotopic Analysis of Sediments from Oxbow Lakes in the Mississippi Delta" (University of Mississippi, 2012). The current report contains elements from each of those reports.

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APPENDIX

Table 6. Pu concentration, $^{240}\text{Pu}/^{239}\text{Pu}$ ratio and $^{239+240}\text{Pu}$ activity for Roundaway Lake (RL1A)

Year	Depth(cm)	Concentration (ppt)	Concentration (ppt)	Ratio	Activity (Bq/Kg)
		^{239}Pu	^{240}Pu	$^{240}\text{Pu}/^{239}\text{Pu}$	$^{239+240}\text{Pu}$
1991	11	0.03	0.01	0.17	0.13
1982	16	0.04	0.01	0.18	0.14
1973	21	0.04	0.01	0.18	0.16
1963	26	0.04	0.01	0.18	0.16
1954	31	0.05	0.01	0.17	0.18
1945	36	0.05	0.01	0.17	0.18
1925	46	0.05	0.01	0.17	0.20
1906	51	0.06	0.01	0.17	0.22
1886	56	0.05	0.01	0.16	0.18
Avg		0.05	0.01	0.17	0.17
SD		0.008	0.001	0.007	0.028
		Activity(mBq/g)	Recovery (%)	Atom Ratio ($^{240}\text{Pu}/^{239}\text{Pu}$)	
Reference Material* (Cert. Value)		6.56±0.20	100.9	0.1915±0.0030	
Reference Material* (Found Value)		6.62		0.17	

Table 7. Pu concentration, $^{240}\text{Pu}/^{239}\text{Pu}$ ratio and $^{239+240}\text{Pu}$ activity for Washington Lake (WL1A)

Year	Depth	Concentration (ppt)		Ratio	Activity (Bq/Kg)
		^{239}Pu	^{240}Pu	$^{240}\text{Pu}/^{239}\text{Pu}$	$^{239+240}\text{Pu}$
2008	1	0.14	0.03	0.18	0.54
2000	8	0.15	0.02	0.16	0.56
1995	11	0.11	0.02	0.19	0.43
1989	15	0.15	0.03	0.18	0.58
1980	21	0.20	0.03	0.16	0.73
1977	23	0.03	0.00	0.16	0.09
1971	26	0.06	0.01	0.17	0.23
1969	27	0.05	0.01	0.21	0.21
1963	30	0.14	0.03	0.18	0.54
1958	33	0.02	0.00	0.17	0.06
	Avg	0.11	0.02	0.18	0.40
	SD	0.06	0.01	0.01	0.23

Table 8. Pb concentration and Isotopic Pb signatures for WL1A.

Sample ID	Depth (cm)	Deposition Date	Total-Pb (ppm)	$^{208}\text{Pb}/^{207}\text{Pb}$	$^{208}\text{Pb}/^{206}\text{Pb}$	$^{207}\text{Pb}/^{206}\text{Pb}$	$^{206}\text{Pb}/^{207}\text{Pb}$	^{210}Pb (cps*)
WL1A-1	3	2006	9.29	2.48	2.02	0.81	1.23	90.4
WL1A-2	11	1995	10.48	2.49	2.02	0.81	1.23	153.2
WL1A-3	15	1989	8.94	2.48	2.03	0.82	1.21	415
WL1A-4	23	1978	8.81	2.50	2.04	0.82	1.21	227.4
WL1A-5	27	1968	5.25	2.47	2.01	0.81	1.23	58.6
WL1A-6	33	1958	6.00	2.52	2.04	0.81	1.23	287.5
WL1A-7	40	1948	5.95	2.49	2.01	0.81	1.20	644.2
WL1A-8	44	1939	7.94	2.48	2.02	0.81	1.22	497.4
WL1A-9	50	1928	8.29	2.48	2.02	0.81	1.23	110.3
WL1A-10	57	1916	9.27	2.48	2.02	0.81	1.21	34.9
WL1A-11	62	1908	4.38	2.51	2.05	0.82	1.21	618.5
Avg			7.69	2.49	2.02	0.81	1.22	285.22
SD			1.97	0.01	0.01	0.00	0.01	224.76

Table 9. Pb concentration and Isotopic Pb signatures for WL2.

Sample ID	Depth (cm)	Deposition Date	Total-Pb (ppm)	$^{208}\text{Pb}/^{207}\text{Pb}$	$^{208}\text{Pb}/^{206}\text{Pb}$	$^{207}\text{Pb}/^{206}\text{Pb}$	$^{206}\text{Pb}/^{207}\text{Pb}$	^{210}Pb (cps*)
WL2-1	10	1992	6.42	2.48	2.01	0.81	1.21	104.9
WL2-2	11	1990	6.75	2.46	2.02	0.82	1.22	39.4
WL2-3	12	1988	2.20	2.46	2.03	0.83	1.20	73.1
WL2-4	13	1985	6.89	2.49	2.04	0.82	1.22	51.2
WL2-5	17	1977	6.54	2.43	2.08	0.86	1.23	436
WL2-6	20	1968	3.80	2.48	2.02	0.81	1.17	1389.6
WL2-7	23	1956	7.31	2.46	2.04	0.83	1.22	48.6
WL2-8	25	1948	4.98	2.47	2.03	0.82	1.21	422.4
WL2-9	28	1937	1.52	2.48	2.00	0.81	1.22	51.9
WL2-10	30	1927	1.23	2.49	2.02	0.81	1.22	63.6
WL2-11	31	1922	1.62	2.49	2.06	0.82	1.22	66.8
WL2-12	34	1907	1.73	2.46	2.01	0.82	1.20	33.7
WL2-13	31	1922	1.46	2.48	2.03	0.82	1.22	67.9
Avg			4.03	2.47	2.03	0.82	1.21	219.16
SD			2.49	0.02	0.02	0.01	0.01	378.03

Table 10. Pb concentration and Isotopic Pb signatures for HL2A

Sample ID	Depth (cm)	Deposition Date	Total-Pb (ppm)	$^{208}\text{Pb}/^{207}\text{Pb}$	$^{208}\text{Pb}/^{206}\text{Pb}$	$^{207}\text{Pb}/^{206}\text{Pb}$	$^{206}\text{Pb}/^{207}\text{Pb}$	^{210}Pb (cps*)
HL2A-1	21	2004	7.09	2.50	2.04	0.81	1.21	46.00
HL2A-2	54	1995	7.23	2.45	2.02	0.82	1.22	52.90
HL2A-3	95	1988	5.48	2.50	2.04	0.81	1.23	101.30
HL2A-4	129	1980	6.99	2.47	2.05	0.83	1.22	366.10
HL2A-5	162	1973	8.76	2.48	2.06	0.83	1.22	652.30
HL2A-6	179	1969	8.10	2.48	2.03	0.82	1.24	834.20
HL2A-7	251	1954	11.95	2.49	2.02	0.81	1.22	207.20
HL2A-8	293	1944	9.93	2.49	2.01	0.81	1.22	135.10
HL8A-9	332	1936	6.57	2.48	2.01	0.81	1.21	978.00
HL2A-10	129	1980	10.00	2.47	2.01	0.81	1.22	331.80
HL2A-11	162	1973	11.23	2.46	2.03	0.82	1.22	696.20
		Avg	8.48	2.48	2.03	0.82	1.22	400.10
		SD	2.06	0.02	0.02	0.01	0.01	334.99

Acoustic Measurements for Monitoring Fine Suspended Sediment in Streams

Basic Information

Title:	Acoustic Measurements for Monitoring Fine Suspended Sediment in Streams
Project Number:	2012MS157B
Start Date:	3/1/2012
End Date:	5/31/2013
Funding Source:	104B
Congressional District:	1st
Research Category:	Water Quality
Focus Category:	Water Quality, Sediments, Surface Water
Descriptors:	None
Principal Investigators:	James P. Chambers, Wayne O'Brian Carpenter, Cristiane Queiroz Surbeck

Publications

1. Quarterly Reports 2012-2013 to Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS.
2. Chambers, J.P., Kleinert, D.E., Carpenter, W.O., Goodwiller, D.G. and Kuhnle, R.A., "Using Acoustic Measurements as a Surrogate Technique for Measuring Sediment Transport" In Proceedings of the 2013 MWRC, Jackson, MS, April 3-4, 2012, http://www.wrri.msstate.edu/pdf/2012_wrri_proceedings.pdf, pg. 231.
3. Chambers, J. "Ultrasonic Measurements of Clays and Silts Suspended in Water" submitted for presentation, Acoustical Society of America fall conference, October 2012.

Mississippi Water Resources Research Institute (MWRRI)

Quarterly Report – (From) 3/1/12 – (To) 3/31/13

Reports due: 1st (March 31); 2nd (June 30); 3rd (Sept. 30); 4th (Dec. 31)

Note: Please complete form in 11 point font and do not exceed two pages. You may reference and append additional material to the report.

SECTION I: Contact Information

Project Title: Acoustic Measurements for Monitoring Fine Suspended Sediment in Streams

Principal Investigator: James P. Chambers

Institution: University of Mississippi

Address: 1 Coliseum Dr.

Phone/Fax: 662-915-5100

E-Mail: chambers@olemiss.edu

SECTION II: Programmatic Information

Approximate expenditures during reporting period:

Federal: \$20,000, Non-Federal (MWRRI): \$20,000.00, Non-Federal (Dept.): \$20,018, In-Kind: _____, Total Cost Share: \$40,018

Equipment (and cost) purchased during reporting period:

Progress Report (Where are you at in your work plan):

The project began in the spring of 2012 with the hiring of Alex Kajdan as a new masters student in Civil Engineering at the end of the spring semester. As a prelude to field measurements, Alex has been conducting literature reviews and is now working with Brian Carpenter to repeat the laboratory based measurements to observe sediment concentration by measuring the attenuation of sound waves. Mr. Carpenter's efforts are part of the grant's matching funds. The principal investigator worked with electronics subcontractors to finalize the development of the hardware components to assemble the field grade system. Alex and co-PI Cris Surbeck have communicated with Matt Hicks at USGS in Jackson to coordinate site visits to Porter and Harris Bayous and to discuss possible locations for the instrument.

Co-PI Carpenter and Alex Kajdan visited Porter and Harris Bayous with Matt Hicks to survey the sites for field measurements. Carpenter and Kajdan also worked through the summer to repeat the laboratory based measurements to observe sediment concentration by measuring the attenuation of sound waves in varying mixtures of clays and silts. Additional measurements using attenuation and backscatter to simultaneously discriminate size and concentration were conducted. The principal investigator continued to work with electronics subcontractors to overcome unexpected setbacks to finalize the development of the hardware components for the field grade system. Work also progressed on the fabrication of the mounting hardware for field measurements.

Carpenter and Kajdan completed the laboratory based measurements to observe sediment concentration by measuring the attenuation of sound waves in varying mixtures of clays and silts. Additional measurements using attenuation and backscatter to simultaneously determine size and concentration were completed. The electronic components for the field unit were completed as well as the mounting hardware for field use. The field unit is being calibrated in

the laboratory tank alongside the laboratory grade equipment.

Carpenter, Kajdan and Goodwiller completed lab calibration and began to use the acoustic surrogate equipment in the field. Grab samples collected at the same time as acoustic data showed good correlation with sediment concentration. Results were presented at yearly MWRRRI conference in Jackson and additional data is being collected and analyzed with approved three month no cost extension.

Problems Encountered:

Previously noted hardware problems delayed data collection.

Nothing major, a few glitches with power and data collection typical with new fielded prototype hardware.

Publications/Presentations (Please provide a citation and if possible a .PDF of the publication or PowerPoint):

Chambers, J.P., Kleinert, D.E., Carpenter, W.O., Goodwiller, B.G., Wren, D.G. and Kuhnle, R.A., Using Acoustic Measurements as a Surrogate Technique for Measuring Sediment Transport in Proceedings of the 2012 Mississippi Water Resources Conference, Jackson, MS, April 3-4, 2012, Proceedings, http://www.wrri.msstate.edu/pdf/2012_wrri_proceedings.pdf, pg. 231.

Ultrasonic Measurements of Clays and Silts Suspended in Water submitted for presentation, Acoustical Society of America fall conference, October 2012.

Kajdan, T.A., Chambers, J.P., Carpenter, W.O. Goodwiller, B.G. Surbeck, C., Monitoring fine suspended sediments in streams using high frequency acoustic signal attenuation measurements, oral presentation at the 2013 Mississippi Water Resources Conference, Jackson, MS, April 2-3, 2013, Proceedings.

Student Training (list all students working on or funded by this project)

Name	Level	Major
Alex Kajdan	Masters	Civil Engineering
Sam Di	Undergraduate	Mechanical Engineering

Next Quarter Plans:

The hardware components for field measurements are in the final stages of fabrication. Once delivered the field system will be assembled and tested. It will be used alongside the laboratory equipment to replicate previous measurements to ensure its utility and then field measurements will commence at select MDEQ sites.

After additional setbacks, the hardware components for field measurements are being completed. Once delivered, the field system will be used alongside the laboratory equipment to replicate previous measurements to ensure its utility and then field measurements will commence at USGS sites visited in Q3.

The hardware components for field measurements will be used alongside the laboratory equipment to replicate previous measurements. Field measurements will commence at USGS sites thereafter.

Analysis of Precipitation Variability and Related Groundwater Patterns over the Lower Mississippi River Alluvial Valley

Basic Information

Title:	Analysis of Precipitation Variability and Related Groundwater Patterns over the Lower Mississippi River Alluvial Valley
Project Number:	2012MS158B
Start Date:	3/1/2012
End Date:	5/31/2013
Funding Source:	104B
Congressional District:	3rd
Research Category:	Climate and Hydrologic Processes
Focus Category:	Climatological Processes, Water Quantity, Groundwater
Descriptors:	None
Principal Investigators:	Jamie Dyer, Andrew Edward Mercer

Publications

1. Quarterly Reports 2012-2013 to Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS.
2. Dyer, J. and A. Mercer, 2013, Assessment of Rainfall Variability and Trends over the Lower Mississippi River Alluvial Valley Using NEXRAD Precipitation Estimates, submitted to Journal of Hydrometeorology (waiting for confirmation).
3. Dyer, J. and A. Mercer, 2013, Assessment of Warm-Season Rainfall Variability and Trends over the Lower Mississippi River Alluvial Valley, poster presented at American Meteorological Society annual conference, Austin, TX, January 2013.

Mississippi Water Resources Research Institute (MWRRI)

Quarterly Report – (From) 03/01/12 – (To) 03/31/13

Reports due: 1st (March 31); 2nd (June 30); 3rd (Sept. 30); 4th (Dec. 31)

Note: Please complete form in 11 point font and do not exceed two pages. You may reference and append additional material to the report.

SECTION I: Contact Information

Project Title: Analysis of precipitation variability and related groundwater patterns over the lower Mississippi River alluvial valley

Principal Investigator: Jamie Dyer

Institution: Mississippi State University

Address: P.O. Box 5448, Mississippi State, MS 39762

Phone/Fax: (662) 268-1032

E-Mail: Jamie.dyer@msstate.edu

SECTION II: Programmatic Information

Approximate expenditures during reporting period:

Federal: \$14,503.33, Non-Federal (MWRRI): \$10,106.03, Non-Federal (Dept.): \$0.00,
In-Kind: \$20,000.00, Total Cost Share: \$30,106.03

Equipment (and cost) purchased during reporting period:

Progress Report (Where are you at in your work plan):

The bulk of the work done at this point in the project has been focused on assembling and quality controlling the multi-sensor precipitation data, which has been completed. The data are currently being analyzed to determine spatial and temporal trends over the LMRV using principal component analysis, which should be completed early in the next reporting period. Additionally, the article related to the first objective of the project is being generated, and should be complete and ready for submission to a peer-reviewed outlet near the end of the next reporting period. This is in agreement with the timeline set forth in the project proposal, and should actually put the project slightly ahead of schedule through the end of the calendar year.

The work on the first project objective dealing with rainfall trends and patterns over the Mississippi Delta has been completed, and a manuscript draft is undergoing revisions. It is anticipated that the manuscript will be submitted for publication to the *Journal of Hydrometeorology* within the next two weeks.

The second project objective, which will compare rainfall patterns to groundwater levels over monthly and seasonal time scales to identify potential recharge zones in the alluvial aquifer, is in the beginning stages. I am in the process of obtaining the groundwater data from the Yazoo Mississippi Delta Joint Water Management District, at which point the master's student being funded from this project will begin formatting, quality control, and gridding of the data. It is anticipated the analysis and interpretation of this part of the project will be done by the end of the Oct. – Dec. reporting period, with the generation of a publication manuscript during the Jan. – Mar. reporting period.

The work on the first project objective dealing with rainfall trends and patterns over the Mississippi Delta has been completed, and a manuscript draft has been submitted to the

Journal of Hydrometeorology. If accepted, page charges of approximately \$2,500 will be charged from the grant.

The second project objective, which will compare rainfall patterns to groundwater levels over monthly and seasonal time scales to identify potential recharge zones in the alluvial aquifer, is in the analysis stage. The groundwater data have been obtained from the Yazoo Mississippi Delta Joint Water Management District, and quality control and organization of the data is near completion. It is anticipated the analysis and interpretation of this part of the project will be done by early February, with the generation of a publication manuscript in late February per the time frame of the grant.

The work on the first project objective dealing with rainfall trends and patterns over the Mississippi Delta has been completed, and a manuscript draft has been accepted to the *Journal of Hydrometeorology* pending revisions. A revised manuscript has been submitted. Additionally, the results from this research were presented at the annual meeting of the American Meteorological Society in Austin, TX in January.

The second project objective, which compares rainfall patterns to groundwater levels over monthly and seasonal time scales to identify potential recharge zones in the alluvial aquifer, is complete and is in the dissemination stage. The results of the research will be presented at the upcoming Mississippi Water Resources Conference (MWRC) in Jackson, MS, and will also be submitted for peer-reviewed publication in the journal *Water Resources Research* (estimated time frame for submission is mid-April).

A no-cost extension was applied for and granted for this project to allow for submission of the second manuscript and travel to the MWRC in early April. However, all project objectives were met according to the estimated work plan.

Problems Encountered:

No problems have been encountered.

Publications/Presentations (Please provide a citation and if possible a .PDF of the publication or PowerPoint):

Quarterly Reports 2012-2013 to Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS.

Dyer, J. and A. Mercer, 2013, Assessment of Rainfall Variability and Trends over the Lower Mississippi River Alluvial Valley Using NEXRAD Precipitation Estimates, submitted to *Journal of Hydrometeorology* (waiting for confirmation).

Dyer, J. and A. Mercer, 2013, Assessment of Rainfall Variability and Trends over the Lower Mississippi River Alluvial Valley Using NEXRAD Precipitation Estimates, poster presented at American Meteorological Society annual conference, Austin, TX, January, 2013.

Student Training (list all students working on or funded by this project)

Name	Level	Major
Alexandria Grimes	M.S.	Geosciences

Next Quarter Plans:

The plans for next quarter include analysis and interpretation of the multi-sensor precipitation data over the LMRAV, followed by the completion of the associated manuscript. This will complete the first objective set forth in the project proposal. In addition, to maintain the project

timeline, the groundwater data over the LMRAV will be obtained from the Yazoo River Water Management District, then assembled and prepared over the next quarter for comparison with the precipitation trends outlined in the first objective.

The next quarter will also see the inclusion of a graduate student in project activities beginning on August 15. The student will be involved in data preparation and quality control, and will also aid in interpretation of statistical results.

The plans for the next quarter include analysis and interpretation of the groundwater data over lower Mississippi River alluvial aquifer in northwest Mississippi, followed by a comparison of the groundwater data with the rainfall patterns generated in the first part of the funded project. This will be done with the assistance of the funded M.S. student over Fall semester. Additionally, a presentation will be given of the results of this project at the American Meteorological Society annual conference in Austin, TX in early January; therefore, plans next quarter will include the generation of a presentation for that conference.

The plans for the next quarter include analysis and interpretation of the groundwater data over lower Mississippi River alluvial aquifer in northwest Mississippi, followed by a comparison of the groundwater data with the rainfall patterns generated in the first part of the funded project. Additionally, a presentation will be given of the results of this project at the American Meteorological Society annual conference in Austin, TX in early January; therefore, plans next quarter will include the generation of a presentation for that conference. Additionally, the results of the groundwater analysis will be submitted for publication in late February and presented at the annual Mississippi Water Resources Conference in April.

Based on this timeline, all work defined in the initial proposal will be finished in time and the results are or will be disseminated in relevant publications and conferences.

The plan for this project includes the generation and submission of the manuscript associated with the second objective of the research to *Water Resources Research*, as well as presentation of the associated research results at the MWRC in early April.

Soil Media Compositions for Water Quality Improvements and Stormwater Management in Urban Flow-through Facilities

Basic Information

Title:	Soil Media Compositions for Water Quality Improvements and Stormwater Management in Urban Flow-through Facilities
Project Number:	2012MS159B
Start Date:	3/1/2012
End Date:	2/28/2013
Funding Source:	104B
Congressional District:	3rd
Research Category:	Water Quality
Focus Category:	Water Quality, Water Quantity, None
Descriptors:	None
Principal Investigators:	Robert Kroger, Warren (Cory) Corrado Gallo

Publications

1. Quarterly Reports 2012-2013 to Mississippi Water Resources Research Institute, Mississippi State University, Mississippi State, MS.
2. 2012 Abstract submitted: Wetland Scientists Conference, Ft. Worth, Texas.
3. 2012 Abstract submitted: Council for Educators in Landscape Architecture Conference, Austin, TX.
4. 2012, Society of Wetland Scientists Conference, Ft. Worth, TX, October 2012.

Mississippi Water Resources Research Institute (MWRRI)

Quarterly Report – (From) 03/01/12 – (To) 03/31/13

Reports due: 1st (March 31); 2nd (June 30); 3rd (Sept. 30); 4th (Dec. 31)

Note: Please complete form in 11 point font and do not exceed two pages. You may reference and append additional material to the report.

SECTION I: Contact Information

Project Title: Soil media compositions for water quality improvements and stormwater management in urban flow-through facilities

Principal Investigator: Dr. Robert Kröger

Institution: Mississippi State University

Address: Department of Wildlife, Fisheries & Aquaculture, Box 9690, MS State, MS 39762

Phone/Fax: 662-325-4731

E-Mail: rkroger@cfr.msstate.edu

SECTION II: Programmatic Information

Approximate expenditures during reporting period:

Federal: \$13,130.90, Non-Federal (MWRRI): \$14,346.14, Non-Federal (Dept.): \$17,821.86,
In-Kind: \$2,265.00, Total Cost Share: \$27,705.87

Equipment (and cost) purchased during reporting period:

Commodities purchased to build fish tanks, soil testing supplies, and materials for flow-thru demonstration.

Progress Report (Where are you at in your work plan):

Objective 1 – Replicated Lab Experiment of Flow-Through Facilities

This project is currently near at the end of the first action (Develop 15 scaled urban microcosms for testing variations of soil depth and composition) which is expected to be completed by June 30th. Assembly of the microcosms has simultaneously begun during the past few months in order to determine if there are any complications before soil media testing begins in July.

During the months of March and April, project related literature was reviewed and the design of the experiment was determined. The first purchases of equipment and supplies were chosen and ordered during the last week of April and the first two weeks of May. This included distribution pumps, cleaning supplies to prepare the microcosms, and assembly supplies.

During May a prototype was assembled and tested to determine the specific design criteria of the microcosms. During this state it was found the tanks contained too much space below the perforated outflow pipe. It was determined that filling this space with sand and separating it with sheets of plastic would keep water from entering the bottom portion of the tanks and eliminate error in water samples that will be taken during the experiment.

During the month of June the project will move forward by completing the prototype tank, installing the pumps that were received in May, and finalizing the soil mixtures that will be used. Samples of soil intended for use in this project have been sent to the soil testing lab at Bost and results are expected by the end of June. Some soil and rock has been purchased and will be delivered the last week of June when the tanks are set for assembly. The remaining rock and soil will be ordered and delivered after the results from the soil lab are received.

The project's first action (Develop 15 scaled urban microcosms for testing variations of soil depth and composition) was completed the first week of August. Two final experiment runs occurred during July and August and water quality samples were collected and analyzed at the

water quality lab in Thompson Hall. The first run tested the systems while saturated and the second run tested their capabilities while completely dry.

Literature on current flow-through designs was reviewed and variations of soil compositions were decided on. Construction of the now 18 microcosms took place during the months of May, June and early July. Three additional tanks were found to be available for use which allowed for more complete testing of the following soil treatments and controls (3 replications each):

- 100% Sand
- 75% Sand, 12.5% Compost, 12.5% Topsoil
- 50% Sand, 25% Compost, 25% Topsoil
- 25% Sand, 37.5% Compost, 37.5% Topsoil
- Filter Fabric, Gravel & Perforated PVC under drain
- Controls

Final purchases of supplies were completed during these months and the distribution pumps were received and calibrated. Soil was delivered in late June and construction of the microcosms was completed by the second week of July (see attached photos in appendix).

During the first week of July the distribution pumps were mounted and fitted with 3/8" clear vinyl tubing. This tubing delivered the synthetic runoff to the microcosms from a 500 gallon tank. The synthetic runoff was composed of 2ppm mixture of phosphorus and nitrogen which was constantly mixed in the 500 gallon tank to ensure uniform distribution of the nutrients.

On July 19th and 20th the first experiment run took place and on August 2nd the second run took place. A hydrograph was used to simulate a 2-inch rainfall event over a compressed 4.5 hour time period. Outflow volumes were documented every 10 minutes along with water quality samples every 30 minutes. For the first experiment (saturated run) the water quality lab analyzed the water samples for: total suspended solids (TSS), total inorganic phosphorus (TIP), turbidity, nitrate and total phosphorus. For the second experiment (dry run) only turbidity, nitrate and total phosphorus were analyzed from the samples.

Preliminary results indicate significant flaws in the design of these facilities leading to much higher than expected soil infiltration rates. Higher infiltration rates in soil treatments reduced the residence time expected for the stormwater runoff in these facilities and as a result did not allow for the desired reduced peak flow or nutrient reduction. The results indicate the need for further research to test structural design modifications of flow-through facilities to increase their water quality and quantity performance.

The project's first action (Develop 15 scaled urban microcosms for testing variations of soil depth and composition) was completed the first week of August. Data analysis from this project was conducted during the fourth quarter and is 75% completed. All descriptive data analysis was conducted during October and were tested for normality of distribution. It was found that the data do not follow normal distribution patterns and transformation of these data to normal distributions was not possible. It was determined that a possible appropriate data analysis test for this type of data was the Kruskal-Wallis Test. In order to test data with the Kruskal-Wallis Test, the data need to demonstrate similar distributions. It was found with the non parametric Levene's Test that the data distributions were significantly different and therefore no significant differences were determined between data sets with the Kruskal-Wallis Test. It is possible there are a few other tests that could apply to this type of data and they are currently being determined and tested.

Final literature was collected for the background and literature review for publications and thesis purposes. Rough drafts of the background and literature review were completed and will be finalized during the next three months after the fourth quarter.

In preparation for an additional experiment run during the spring, PVC pipes were perforated and placed in the tanks in order to test alternatives to dispersing the inflow water. These diffusers for the inflow are thought to be one solution to design flaws found in

the structural design of the flow-through facilities.

Analysis of the data collected from the project's first action continued through this quarter. The data were analyzed using Microsoft Excel and SPSS and graphs and tables representing the results were completed. A first draft of a publication is underway and the Journal of American Water Resources Association (JAWRA) was selected as a suitable place to seek publication.

During the month of March the project was presented at the Council of Educators in Landscape Architecture (CELA) conference in Austin, TX and at a research day fair at the Mississippi State Capitol. An abstract was submitted and accepted for another regional conference at the American Society of Landscape Architects (ASLA) Twin States Conference in Orange Beach, AL.

Objective 2 – Flow-Through Demonstration Facility

No progress has yet been made on Objective 2.

During August and September a design for the demonstration facility was created and some supplies were purchased. Quotes were requested in the middle of September for the large fish tank that will be used for the facility.

During October and November the demonstration facility design was finalized and construction for the first attempt was completed by the beginning of November. After construction it was apparent the weight of the facility was too great and that more of the internal space would have to be replaced with a lighter material. The soil components were disassembled and replaced with foam blocks. The facility is currently sitting at south farm and the soil is settling before plantings are established.

During the last quarter of an information brochure and demonstration board was designed and printed for outreach events and conferences. Demonstration facility construction was completed and was presented at the Mississippi State Capitol along with other research from the College of Agriculture and Life Sciences.



Problems Encountered:

Some work was delayed the first two weeks of May due to the reconfiguration of the project site at South Farm and a few days that were dedicated towards site preparation were delayed due to a water main break near the building.

It was expected that the microcosms would be completed by June 30th and they were not completely constructed until the second week of July. This was due to necessary changes in

the design of the bottom layer of the microcosms. The original attempt to secure the plastic sheeting was unsuccessful due to significant leaking. A new layer was inserted that came up the sides of the tank to the top, ensuring no leakage to the filler layer below the outflow pipe.

The flow-through demonstration facility was thought to be completed; however the weight of the soil and rock needed for it was underestimated. The facility was disassembled and reassembled to include foam blocks in the interior in order to greatly reduce the amount of weight.

The demonstration facility was temporarily stored indoors and the plants did not survive. Plants will need to be reestablished before the next conference and appropriate, long-term storage needs to be determined.

Publications/Presentations (Please provide a citation and if possible a .PDF of the publication or PowerPoint):

Abstracts have and will be submitted to:

- 2012 Society of Wetland Scientists Conference in Ft. Worth, TX (October)
- 2013 Council for Educators in Landscape Architecture Conference in Austin, TX (March)
- 2013 Mississippi Water Resources Research Institute Conference (April)

Research was presented this quarter at the following:

- Mississippi Public University Capitol day (March 6)
- 2013 Council of Educators in Landscape Architecture Conference (March 27-30) Research will be presented this quarter at the following:
- 2013 Mississippi Water Resources Research Institute Conference (April 2-3)
- 2013 ALSA Twin States Conference in Orange Beach, AL (April 11-13)

Student Training (list all students working on or funded by this project)

Name	Level	Major
Emily Overbey	Master's	Landscape Architecture

Next Quarter Plans:

Objective 1 – Replicated Lab Experiment of Flow-Through Facilities

The major actions of Objective 1 are planned to be completed during the next quarter. These include:

- Completing the development of 15 scaled urban microcosms for testing variations of soil depth and composition,
- Testing the microcosms for their ability to retain stormwater during specific storm events, and
- Testing the microcosms for their ability to filter sediments and nutrients.

We will also begin to look for opportunities to present the preliminary results to gain peer feedback on the research.

During early July all supplies should be ordered and assembly of tanks will take place. After the tanks are assembled and prepped, trial runs of the experiment will take place to determine if there are any adjustments that need to be made before the final experiment occurs. The experiment is intended to take place at the end of July and early August if not sooner. Water samples from the project will be sent to the water quality testing lab in Thompson Hall during early August and results should be organized and the beginning stages of data analysis should begin in September.

During the fourth quarter the following tasks and progress are scheduled:

- Cleaning, organizing and analysis of data provided by the water quality lab
- Determine appropriate journals for paper submissions
- Start writing and submitting for publication

During the next three months the following tasks and progress are scheduled:

- Finalizing data analysis and literature review for publication and thesis
- Determine appropriate journals for paper submissions
- Present at CELA Conference in Austin, TX and WRRRI Conference in Jackson, MS
- Submit for publication by April 15th
- Conducted an additional run of the experiment with the diffusers

During the next three months the following tasks and progress are scheduled:

- Finalize tables and figures and write results and discussion for publication and thesis
- Present at WRRRI Conference in Jackson, MS and ASLA Twin States Conference in Orange Beach, AL
- First draft of publication by April 15th
- Conduct an additional run of the experiment with the diffusers during June 2013
- Conduct data analysis on June run

Objective 2 – Flow-Through Demonstration Facility

The major work actions of Objective 2 are expected to be substantially completed by the end of the next quarter. These include:

- Developing a transportable working model of a flow-through facility, and
- Developing a fact sheet that discusses the results of the study and promotes the technology.

The major work actions of Objective 2 have been implemented during this quarter and will be completed during the fourth quarter.

- Completed construction of the flow-through facility demonstration model, and
- Completion of a fact sheet which discusses the model and the results of the study.

The major work actions of Objective 2 were completed during the fourth quarter and will be completed in the next three months:

- Determine plant material and establish them during the appropriate season, and
- Completion of a fact sheet which discusses the model and the results of the study.
- Bring demonstration facility to WRRRI Conference

The major work actions of Objective 2 have been completed. Future actions include:

- Reestablish plant material,
- Find a place to store the demonstration facility,
- Bring the facility to outreach functions and conferences including MS WRRRI and ASLA Twin States Conferences.

Information Transfer Program Introduction

The Mississippi Water Resources Research Institute addresses research and outreach efforts targeted at maintaining plentiful, quality water supplies throughout the state. The Institute is a hub for information and expertise on water resources issues within the state and region. We do this in full partnership with our public and private cooperators.

The Mississippi Water Resources Research Institute is committed to providing public outreach, education opportunities, and assisting with economic development activities. Researchers and students have the opportunity to present their research by giving oral and poster presentations. Also included are plenary sessions and panel discussions. Those persons subscribed to the MWRRI listserv receive newsletters, award opportunity notices, job opportunities, conference information, and timely water related information.

Information Transfer Program - Publications

Basic Information

Title:	Information Transfer Program - Publications
Project Number:	2012MS188B
Start Date:	3/1/2012
End Date:	2/28/2013
Funding Source:	104B
Congressional District:	3rd
Research Category:	Not Applicable
Focus Category:	None, None, None
Descriptors:	
Principal Investigators:	, Wayne Wilkerson

Publications

1. Mississippi Water Resources Research Institute. 2012. Newsletter, Volume 2012, Summer Issue, 6 pages. http://wrri.msstate.edu/newsletter/newsletter_0612.asp
2. Mississippi Water Resources Research Institute. 2013. Newsletter, Volume 2013, Spring Issue, 6 pages. http://wrri.msstate.edu/newsletter/WRRI_Spring_Newsletter_2013.pdf
3. Mississippi Water Resources Research Institute. 2013. Newsletter, Volume 2013, Special Issue. <http://www.wrri.msstate.edu/newsletter/EPA%20Center%20of%20Excellence%20Announcement.pdf>
4. Mississippi Water Resources Research Institute. 2012. Strategic Plan 2012-2013 Plan.
5. Mississippi Water Resources Research Institute. 2012. Project: Research and Education to Advance Conservation and Habitat (REACH) information.
6. Mississippi Water Resources Research Institute. 2012. Success Profile: Toyota Corporation.
7. Mississippi Water Resources Research Institute. 2012-2013. Supported Projects Locations.
8. Mississippi Water Resources Research Institute. 2012. 2012 Mississippi Water Resources Conference, Program Book, 16 pages.
9. Mississippi Water Resources Research Institute. 2012. 2012 Mississippi Water Resources Conference, Proceedings, 246 pages. http://www.wrri.msstate.edu/pdf/2012_wrri_proceedings.pdf

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From the Director's Desk

Greetings from the Mississippi Water Resources Research Institute. This quarter brings to a close my first year as Director. I feel we have made a successful transition.

During the past year I made a concerted effort to make as many contacts as possible with our stakeholders to raise the visibility of the Institute. The tally for the first year was 81, and included conference presentations, public meetings, and individual visits all over the state of Mississippi, as well as Washington D.C. So far, in 2012, I have made 51 such contacts. I feel these networking efforts will pay dividends in the future.

In April we hosted our annual conference in Jackson at the Hilton on County Line Road. Page 3 has a more complete

summary of the event. I was very pleased with the number of attendees, and the quality of the presentations. We received very positive feedback from our exit survey about the facilities and location as well as conference content. And even though we eliminated some of the students registration fees, we showed a small profit. I would like to thank all the Advisory Board members who were involved in the planning effort, and a special thanks to Jessie Schmidt for her tireless efforts to make sure the conference was a financial and educational success.

Another important event occurred this spring. The Institute normally receives funding from the state of Mississippi to use as match for external grant applications. Last year



we received \$120,531. This year our funding was increase to \$180,531. **A 49.8% increase !!** We will use a significant portion of that increase to fund REACH, an exciting new water quality improvement initiative started by Dr. Robert Kröger. A complete description of the program may be found on Page 2.

Enjoy. And have a safe summer.



2013 USGS Annual Competitive RFP Coming Soon !

During the month of June, the Institute's Advisory Board will be finalizing the RFP for our annual proposals. The call will closely follow the same format as was issued in 2012.

The Institute hopes to release the complete package around the first of July, but research scientists who plan to submit should be developing

their research ideas and forming their teams now. Significant external matching funds will be valued highly.

Once again, consideration will be given to junior (non-tenured) faculty and research scientists acting as Principal Investigator. Senior faculty are encouraged to serve as Co-Pi's. Graduate student participation is also encouraged.

REACH

Research and Education to Advance Conservation and Habitat



REACH is an innovative, grass-roots collaboration that will integrate research and outreach on specific farms to demonstrate the benefits of conservation on agricultural lands. The products developed by this program will be used to further conservation delivery and adoption in agriculture.

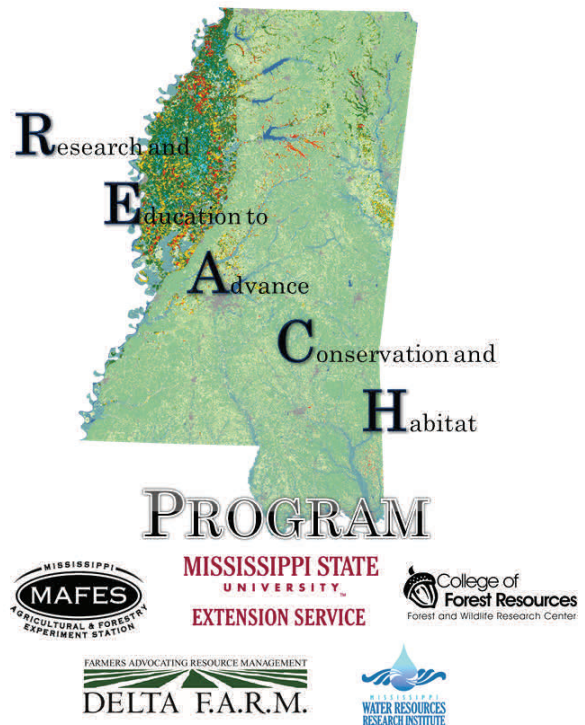
There is increasing societal awareness of natural resource concerns in both agricultural systems and the downstream receiving water bodies. These concerns are reflected in current policy discussions at both Federal and State levels, where there is a desire for 1) increased accountability with regard to agriculture's impact on the environment, and 2) documentation of how well on-the-ground programs and conservation practices are doing to improve our natural

resources. REACH is a producer led program that will address these two points.

The REACH program goal is to create a network of cooperative farms in Mississippi, with variable agricultural systems, degrees of conservation initiatives and ecosystem monitoring to illustrate the success of conservation practice implementation on landscape stewardship. These farms will provide producers, conservationists, educators and policy maker's key information to better implement and advocate management practices orientated around various local and regional objectives (i.e., targeted nutrient reductions, or habitat restoration).

The REACH program will be a MSU-extension steered program that is strategically implemented to leverage, sustain, and continue the efforts of regional and state led strategies. "REACH is the perfect marriage of research and extension, and its sole purpose is to help the farming community," Kröger said. "REACH will be a service to Mississippians to help improve landscapes, and will showcase what a good job landowners are doing."

"Critical to conservation practice implementation and adoption is the know-how of how it works, why it works, and the ability to deliver the relevant information to who it can help" said Dr. Gary Jackson, Director of Mississippi State Extension Service. "REACH will help our landowners to foster improved landscape stewardship and agricultural production systems by giving them the hands-on help they require." REACH plans a multi-year, multi-farm program that will generate research-based results, create opportunities for field days and demonstration sites, provide justification for federal investments in conservation and support the health of Mississippi's water resources, both inland and downstream to the Gulf of Mexico.



For more information contact Dr. Robert Kröger. His e-mail address is rkroger@cfr.msstate.edu. His office phone number is 662.325.4731.

2012 Mississippi Water Resources Conference



More than 150 participants, 26 of which were students, gathered in Jackson, MS at the Hilton Hotel April 3rd and 4th to take part in the 2012 Water Resources Conference. Over the course of a day and a half, nine invited speakers and 59 presenters shared information focusing on the conference theme of "Water, Sustainability, and Climate". The conference was well attended by water researchers from all across the South. But the award for highest mileage claim goes to Ms. Guisy Pappalardo, who travelled all the way from Sicily. Guisy will be a visiting Fulbright Scholar at Mississippi State University this fall, working with staff in the Water Resources Research Institute and Department of Landscape Architecture as she completes her PhD at the University of Catania.

Student presenters competed for first- and second place monetary awards in both oral and poster presentations categories. Of 20 poster presentations, eight were delivered by students. Winning first place was Natalie Sigsby, a graduate student in Mississippi State University's Department of Civil Environmental Engineering. Natalie's poster was titled "Sedimentation Processes of Perdido Bay." Second place went to

Min Lee, who is a graduate student in Mississippi State University's Department of Forest Products. Min's poster was titled "Formaldehyde released in leachate from medium density fiberboard (MDF) buried in a simulated landfill."

Twenty students made oral presentations during the conference. Caroline Andrews, a graduate student in Mississippi State University's Department of Wildlife, Fisheries & Aquaculture received first place for her presentation on "Predicting nitrogen and phosphorus concentrations using chlorophyll-a fluorescence and turbidity."

Alex Littlejohn, a graduate student in Mississippi State University's Department of Wildlife, Fisheries & Aquaculture, garnered second place for his presentation on "Low-Grade Weirs: An Innovative Best Management Practice for nitrate-N Mitigation." Special thanks go to Mississippi Water Resources Research Institute, Mississippi Water Resources Association, Weyerhaeuser Company, and Yazoo- Mississippi Delta Levee Board for sponsoring the student competition awards.

The luncheon speaker on Tuesday, April 3 was Eric Evenson, USGS Coordinator for the National Water Census since 2008. Mr. Evenson has been with the USGS since 1992, having also served as Associate District Chief and District Chief, and Regional Program Officer in the Northeastern Region Water Program. Mr. Evenson's presentation reviewed current projects and themes in the Survey's Science Plan as prioritized by USGS as well as changes and modifications to enhance the program throughout the country.

Wednesday's luncheon speaker was Stephen Kirkpatrick, wildlife and nature photographer. Mr. Kirkpatrick's latest presentation, Sanctuary, is a tribute to rare and endangered species and habitats of the Mississippi Coastal Plain.

Sponsors for the conference included Florence & Hutcheson, Inc., G.E.C. Inc., Michael Hatcher & Associates Inc., Mississippi Department of Environmental Quality, Mississippi State University Department of Geosciences, Mississippi State University Department of Landscape Architecture, Mississippi Water Resources Association, Mississippi Water Resources Research Institute, U.S. Geological Survey, Weyerhaeuser Company, and Yazoo- Mississippi Delta Levee Board. Exhibitors present at the conference included Florence & Hutcheson Inc., G.E.C. Inc., Mississippi Department of Environmental Quality, Pickering Firm, Inc., REACH program facilitators, and U.S. Geological Survey.

2012 Mississippi Water Resources Conference



Upper left - From left, Carol Moss, Patricia Wilson, and Jessie Schmidt.

Upper right - Attendees enjoying the Wednesday lunch.

Center left - Robbie Kroger's grad student mob enjoyed the Tuesday reception.

Center right - MS Delta Levee Board representatives including David Cotton, William Dodd, Willie Gregory, Ralph Sewell, David Williams, and Ted Winters.

Bottom left - Wednesday panel discussion included Larry Jarrett, Cris Surbeck, William McNally, Trey Cooke, Coen Perrott

Bottom right - Eduardo Arias, MSU-GRI, is presented with the Dell monitor FloHut Inc. door prize by Ms. Schmidt.



WRRRI Summer 2012 Profile**Researcher: Joseph Massey, Plant & Soil Sciences, Mississippi State University****Project: Water-Conserving Irrigation Systems for Furrow and Flood Irrigated Crops in the Mississippi Delta**

Mississippi's total water use is over **3.0 billion gallons** per day (BGD). Irrigation of agricultural crops accounts for over 60% of that amount. Mississippi relies heavily on agricultural commodity production as a source of revenue and jobs. And rice, one of Mississippi's top commodities and exports, relies heavily on water for germination and growth. Unfortunately the demand for water use for irrigated crop production has put enormous pressure on Mississippi Delta's Mississippi River Valley Alluvial Aquifer

groundwater supply. The Mississippi Water Resources Research Institute (MWRRI) is working with researcher Dr. Joe Massey, an Associate Professor of Plant and Soil Sciences at Mississippi State University, to find alternatives to current rice cultivation practices that might result in less water required to produce the same amount of rice.

Massey's MWRRI-sponsored research has shown that intermittent irrigation can reduce the amount of water needed to grow a successful rice crop by up to 50 percent, compared with the conventional method of continuous flooding. Another find was that managing a rice flood by maximizing the distance between the water level and the

top of the levee gate can reduce overall water use by minimizing over-pumping and runoff. He also designed a rain gauge that helps farmers tell from a distance how wet their fields are, and he's now researching ways to remotely and automatically shut off water pumps to save rice producers time and money.

Data generated by Dr. Massey's previous research indicate a potential savings of 150,000 acre-feet of irrigation water on rice alone. Less water pumped results in reduced production costs. If Dr. Massey's research was implemented on only 200,000 of the 310,000 acres of rice planted in 2010 in the Delta, it could easily result in over **\$5,000,000** in reduced production fuel costs. This is quite a potential return on the \$18,039 of federal funds invested in Dr. Massey for FY 2011.



Mississippi Water Resources Research Institute

The mission of the Mississippi Water Resources Research Institute (WRRRI) is to provide a statewide center of expertise in water and associated land-use and to serve as a repository of knowledge for use in education, research, planning, and community service.

The WRRRI goals are to:

- (1) Serve public and private interests in the conservation, development, and use of water resources.
- (2) Provide training opportunities in higher education whereby skilled professionals become available to serve government and private sector alike.
- (3) Assist planning and regulatory bodies at the local, state, regional, and federal levels.
- (4) Communicate research findings to potential users in a form that encourages quick comprehension and direct application to water related problems.

Two Year Strategic Plan 2011-2013

Research

- Continued support for food/fiber/fuel mission.
- Added focus on urban storm water issues, especially water quality.
- Assess Green Infrastructure solutions for waste water treatment.
- Investigate innovative monitoring solutions for BMP effectiveness.
- Enhance working relationships with other Universities.
- Quantify outcomes from WRRRI research and support funding.

Education

- Develop a Certificate of Watershed Protection. This could be offered to traditional on-campus graduate students as well as to off-campus professionals utilizing distance learning.
- Utilize demonstration projects as service learning.
- Expand the number of funded graduate students.

Engagement/Outreach

- Offer workshops for technology transfer and revenue generation.
- Return the annual conference to Jackson, MS.
- Revise the conference agenda to reflect desire for more applications.
- Expand working relationship with MSU Extension.

Discrimination based upon race, ethnicity, religion, gender, national origin, age, disability, or veteran's status is a violation of federal and state law and MSU policy and will not be tolerated. Discrimination based upon sexual orientation or group affiliation is a violation of MSU policy and will not be tolerated.

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From the Director's Desk

"These are the times that try men's souls". Thomas Paine

These truly are difficult times that we live in, for both our state and our nation. The major issue for the WRRI is the financial uncertainty caused by the gridlock in Washington. Our parent organization, the USGS, is facing significant budgetary stress due to the sequestration. As a result, the annual base grants provided to each state through the 104(b) program has been reduced by 40%. This means that we will be unable to fund one of our three research projects scheduled to begin March 1. We hope these funds will be restored later in the year.

The budgetary reductions will also be felt at our annual

conference in April. The sequestration has forced many federal agencies to reduce or eliminate non-essential travel. As a result, our USGS partners will be unable to attend, even though the conference will be held in Jackson. We had also hoped to have some EPA Region 4 staff attend our conference, but they had to cancel as well.

On a more positive financial note, the WRRI did see one support budget increased. The State of Mississippi normally provides matching funds for federal grants. For FY 2013 these funds were increased from \$120,531 to \$180,531, almost a 50 % increase. This year we invested most of the increase in REACH, a farmer led initiative being directed by Dr. Robbie Kröger. The WRRI



funds will be used to leverage other external funding.

When we send out the next newsletter I hope to have more positive news. We hope that the federal funds will have been restored. We hope to be able to maintain our current state funding levels. And we currently have three initiatives in the works that could have major implications for the WRRI. Stay tuned.

Wayne

Contact Information

Dr. Jairo Diaz
Director/Assistant Professor
1000 ASU Drive #209
Alcorn State, MS 39096
Phone: (601) 877-3368
Email: jdiaz@alcorn.edu
Website: www.alcorn.edu/mrrc/

Congratulations to Dr. Jairo Diaz Ph.D.

Dr. Diaz recently assumed the position of Director of the Mississippi River Research Center (MRRC), located at Alcorn State University. The MRRC was created in the mid-1990s to combine and integrate research, teaching, and outreach in agriculture, applied sciences, environmental studies, advanced technologies, and

human sciences. The MRRC mission is to advance knowledge in preservation, conservation, and improvement of water quality while balancing economic and environmental impact. The MRRC provides capabilities in sustainable watershed management, soil & water quality laboratory analysis, and watershed assessment & modeling.

2013 USGS 104b Funded Projects

“Interdisciplinary Assessment of Mercury Transport, Fate and Risk in Enid Lake, Mississippi”

Dr. Xiaobo Chao
Senior Research Scientist
NCCHE
The University of Mississippi (UM)
University, MS 38677

Dr. James V. Cizdziel
Assistant Professor
Dept. of Chemistry
UM

Dr. Kristie Willett
Associate Professor
Dept. of Pharmacology
UM

Dr. A.K.M. Hossain
Research Scientist
NCCHE
UM

“Non-linear downward flux of water in response to increasing wetland water depth and its influence on ground-water recharge, soil chemistry, and wetland tree growth”

Dr. Gregg Davidson, Professor
Department of Geology and Geological Engineering
The University of Mississippi
University, MS 38677

“Identification of Recharge Zones in the Lower Mississippi River Alluvial Aquifer Using Isotopic Characterization of Perception and Groundwater”

Dr. Jamie Dyer, Associate Professor
Department of Geosciences
Mississippi State University
P.O. Box 5448
Mississippi State, MS 39762

Dr. J.R. Rigby Ph.D.
Research Hydrologist
USDA-ARS

Change of Leadership at the Mississippi Water Science Center

Good-Bye Mickey, Hello Scott

Mickey Plunkett, former Director of the Mississippi Water Science Center, retired at the end of 2012. Mickey began his career as a cooperative education student on January 2, 1974. Upon graduation from Mississippi State University in 1980 he was hired by the Mississippi District as a civil engineer. After working in both the Studies and Data Sections he was promoted to Chief of the Surface Water Records Unit in 1985. He was selected as the Data Section Chief in 1990. Since being selected to be the Director of the Mississippi Water Science Center in 2001 Mickey represented the Region on various national efforts and has been a representative of the agency in Gulf of Mexico issues and organizations while overseeing operations in Mississippi. Most recently he was selected to represent flood issues on the Science Strategy Planning Team for the USGS Hazards Mission Area. He retired after 37 years of service.

Scott Gain will serve as the interim Director of the Center. Scott has been the Director of the Tennessee Water Science Center for the last 15 years and has worked for the USGS for more than twenty eight years. He started with the USGS as a project chief in Fort Worth, Texas and subsequently worked as project chief and Data Chief in Orlando, Florida before moving to Tennessee. He holds a Master's in Forest Hydrology from the University of Florida, a BS in environmental science from Richard Stockton College of New Jersey and taught as a U.S. Peace Corps volunteer at Pampanga Agricultural College in the Philippines for two years before joining the USGS. Scott's technical experience with the USGS has included studies of hydro-acoustics, storm-water mitigation, nutrient loading to lakes, Karst wetland hydrology, salinity mixing in estuaries, and ecological flow requirements. In his time as Director for Tennessee Scott has also served on numerous Bureau committees and review teams and served for short periods as Acting Director for Alabama and Program Officer for the SEA. Scott will continue serving as the Tennessee Water Science Center Director while taking on the interim assignment in Mississippi.

2013 Mississippi Water Resources Conference

Water, Sustainability, and Climate

April 2-3, 2013



Mississippi is fortunate to currently have plentiful supplies of clean water. However, potential problems loom on the horizon. The Mississippi Water Resources Conference provides a forum for the water resources community to discuss these complex water issues facing our state, region, and nation. Research findings and applications from state and federal agencies, as well as colleges and universities, will be shared with conference attendees.

Scheduled for April 2-3 in Jackson, MS, this year's conference promises to be an exciting event. This will be the water conference you will not want to miss, with exciting presentations and keynote speakers, as well as a panel forum comprised of representatives from MDEQ who will share insight into water quality and quantity issues. Poster sessions will showcase student work, and exhibitors from the private and public sectors will be in attendance.

ance.

Location - Jackson Hilton, Jackson, MS

The conference will be held at the Jackson Hilton, in Jackson MS. Reservations may be made by phoning 1-601-957-2800. Mention group code "WATER" to receive the special group rate.

Luncheon Speaker Tuesday April 2

Mr. Ben Scaggs - Director
U.S. EPA Gulf of Mexico Program

Luncheon Speaker Wednesday April 3

Dr. Robert Watts - Professor Emeritus
Tulane University

Technical Sessions

- 1 Water Resources Protection & Management
- 2 Surface Water Quality #1
- 3 Nutrient Reduction & Management #1
- 4 Watershed Assessment & Management
- 5 Stormwater Assessment & Management
- 6 Aquatic Ecosystems
- 7 Delta Hydrology
- 8 Monitoring & Modeling: Pearl River Basin
- 9 Surface Water Assessment & Monitoring
- 10 Irrigation Practices & Management
- 11 Nutrient Reduction & Management #2
- 12 Surface Water Quality #2



Visit our Web site at www.wrri.msstate.edu or contact Jessie Schmidt at 662.325.3295 for more conference details.

Current WRRI Supported Research and Outreach Projects

Project: Research and Education to Advance Conservation and Habitat (REACH)

- The REACH program goal is to create a network of cooperative farms in Mississippi to illustrate the success of conservation practice implementation on landscape stewardship.
- Currently, REACH has enrolled 32 Mississippi farms in the program. They are located in 20 counties, and total over 100,000 acres.
- During FY 2013 the WRRI committed \$50,000 in matching funds to help REACH leverage over \$300,000 in other funding. The funds were used to support one MSU graduate student, match the purchase of field monitoring equipment, and provide building materials for students to construct wooden structures to house field data collecting equipment. The student project will be completed at Hinds Junior College.



Project: MDEQ/EPA 319 Rotten Bayou Project



Rotten Bayou is a coastal watershed located in Hancock County, Mississippi covering approximately 35 square miles. The bayou drains into the Bay St. Louis, which later drains into the Gulf of Mexico. This area is under pressure from population growth, urbanization, and agricultural practices such as cattle farming. The watershed has been identified by the Mississippi Department of Environmental Quality (MDEQ) as having impairments such as low dissolved oxygen, turbidity, and excessive nutrient loads.

The WRRI, with the assistance of faculty in the Department of Landscape Architecture, has a contract with MDEQ to assist the newly formed town of Diamondhead identify structural and non-structural Best Management Practices that will help improve water quality in Rotten Bayou. The Institute committed \$5,000 in state matching funds to help secure a \$98,000 grant that has design and policy implications for the entire Mississippi Gulf Coast metropolitan area.

Project: USGS 104b Annual Competitive Grants



Annually the WRRI receives federal funds from the U.S. Geological Survey to support water related research. During FY 12 and FY 13 a total of six research projects were funded. Three projects were funded at MSU and three at UM.



WRRRI Spring 2013 Profile

Researcher: Dr. Cristiane Q. Surbeck, Assistant Professor of Civil Engineering, University of Mississippi

Tell us a little about your background and your current faculty position.

I have a degree in civil engineering from Maryland and graduate degrees in environmental engineering from the University of California, Irvine. I worked for an environmental engineering consulting firm in southern California for almost 8 years when I decided to plunge into academia and go for a PhD and then a professor position. I'm in my sixth year in a tenure-track position and it's been a whirlwind of activities. I've developed courses in water resources and environmental engineering, incorporating my experiences from consulting, from my research, and even sometimes from my experience growing up in Brazil. My pride and joy when it comes to teaching is the service-learning course that I developed on drinking water treatment. For this course I've partnered with the organization Living Waters for the World, which has a facility in Oxford, and my students help research and test their prototype water treatment systems for communities around the world in need of clean water. A big highlight of the last year was my trip to Togo, Africa, with Engineers Without Borders, when we struck an agreement with a rural village to build a school together (pictured). My research projects have also spanned a wide variety. I try to collaborate with as many partners as I can so we can maximize our resources. So far I've had projects with the USDA National Sedimentation Laboratory, the National Center for Physical Acoustics, the US Geological Survey, EarthCon, and other universities. Even in service I try to connect to my teaching and research. For example, I'm a member of the Institutes for Higher Learning (IHL) Energy Management Council, where we are informed of energy saving measures taken by the Mississippi public universities. Again, this is information that I can relay to my students and use in research someday.



What are your current research activities?

Jim Chambers (UM Mechanical Engineering) and I have a project funded by the MWRRRI to develop an acoustic device to monitor fine suspended sediments in surface waters. On a very different subject, I'm working with a graduate student on a financial model for public-private partnerships in water infrastructure. We're looking at capital and operation and maintenance costs of existing infrastructure in Mississippi and seeing how the public and private sectors could benefit if they become partners in funding those projects. We've had some help on this one from the World Bank, MSU Extension, and the Mississippi Department of Health. Another project I have is in collaboration with the USGS and the MDEQ. We're looking at determining sources of fecal bacteria, which are indicators of pathogens, in the Ross Barnett Reservoir. On another very different note, I'm on the steering committee of a research network funded by the National Science Foundation on defining and assessing social sustainability in the domains of water, food, and health. This is a multidisciplinary team from the social sciences, humanities, and engineering.

How does the Water Resources Institute fit into your future plans? How can we help you to be successful?

The Water Resources Institute has already been a fantastic connection to water researchers in the state of Mississippi. Networking at the annual conference and receiving research funds from MWRRRI are how I've become versed on the state's water infrastructure and how I can impart knowledge to students who will also work on state water issues. Through the Institute I've also learned what are the state's primary water concerns. I think the Institute should continue to connect the enthusiastic water professionals in the state so we can continue to take steps to solve some of these very complicated problems.

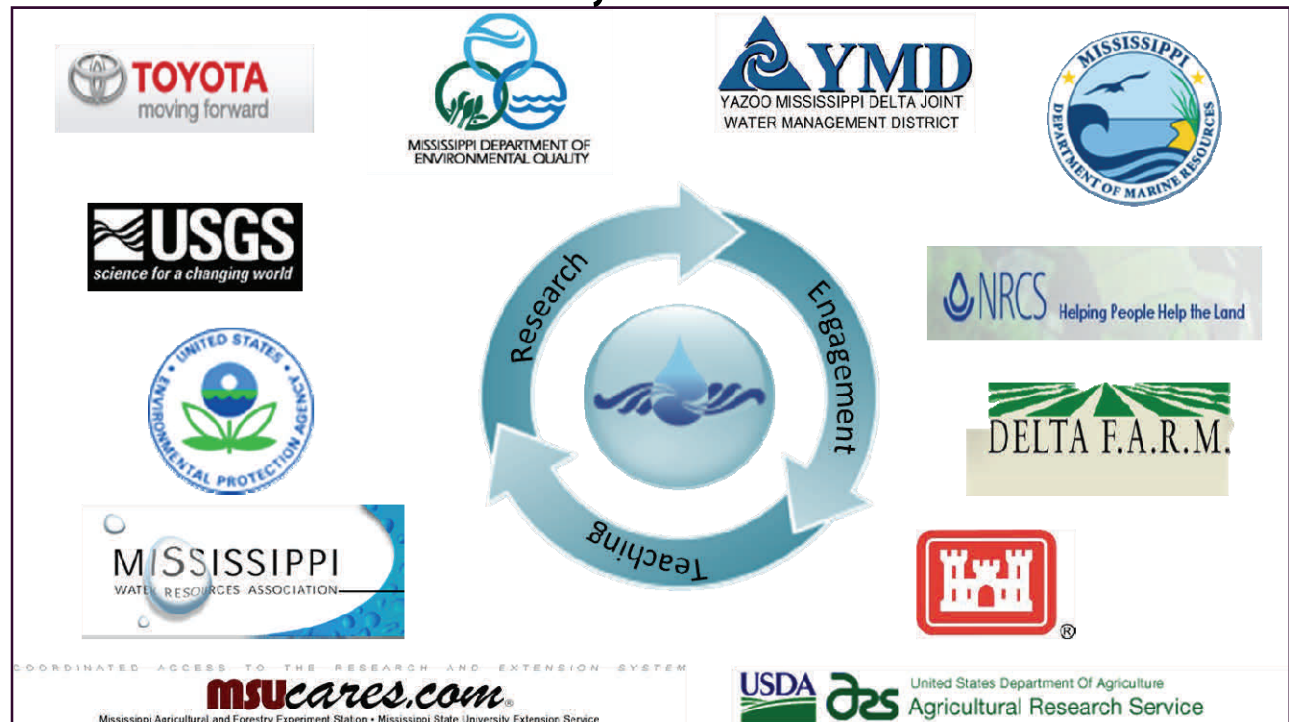


The Water Resources Research Institute (WRRI):

- ◇ Was designated by the legislature as a state research institute.
- ◇ Provides training and educational opportunities for K-12 students as well as those in higher education.
- ◇ Communicates research findings through conferences, workshops, and other engagement opportunities.



The Institute acts as a clearinghouse for:



This is a very special edition newsletter. I am please to announce that on Tuesday, April 9 the U.S. Environmental Protection Agency (EPA), the Mississippi Department of Environmental Quality (MDEQ), and Mississippi State University (MSU) signed a memorandum of understanding (MOU) creating a Center of Excellence for Watershed Management in Mississippi. The Center will be administrated through the Mississippi Water Resources Research Institute (MWRRRI), but will be a collaborative work effort between MWRRRI, MDEQ, and EPA.

This is not a paradigm shift to the MWRRRI's Mission Statement. What it does in essence is to build on and expand the Institute's current working relationship with EPA and MDEQ with regard to watershed management. The following bullets contain certain portions of the MOU that I felt would be of special interest to our stakeholders.

The complete MOU may be found on the first page of the MWRRRI WEB site at www.wrri.msstate.edu.

- The Parties agree that the primary purpose of the Center of Excellence for Watershed Management Program is to utilize the diverse talent and expertise of colleges and universities in various geographic areas of Mississippi to provide hands on practical products and services to help communities identify watershed-based problems and develop and implement locally-sustainable solutions.
- MWRRRI, once designated as the Mississippi Center of Excellence for Watershed Management, will serve as the point-of-contact and primary coordinating entity for colleges and universities in Mississippi with water-related expertise.
- As a Center of Excellence for Watershed Management, MWRRRI will actively seek out local stakeholders that need cost effective technical tools for scientific support, engineering support, and information technology, as well as assistance with project management, outreach and education, and watershed planning.
- MWRRRI will work with colleges and universities in Mississippi to engage students (graduate and undergraduate), faculty and staff from the full suite of disciplines needed to adequately address specific watershed issues. When needed, MWRRRI will also draw upon other local, state, federal and Center of Excellence for Watershed Management Network resources and expertise to minimize duplicative efforts.
- In addition to helping build local stakeholder capacity, MWRRRI will also work with colleges and universities in Mississippi to build their capacity to teach environmental and watershed management approaches to both traditional and nontraditional students.
- MWRRRI will pay special attention to local stakeholders which also represent underserved populations in



watershed communities and, when possible, seek ways to work with these unique populations. This approach will build upon a MOU between MWRRRI and Alcorn State University designed to maximize water related research in the state of Mississippi.

I will be traveling across the state this summer visiting with Advisory Board members and other stakeholders to discuss the opportunities this MOU provides regarding watershed management. If you have specific questions, or would like to set up a meeting, please contact me directly via e-mail (waynew@ext.msstate.edu) or by phone (662.694.1166).

Wayne

MISSISSIPPI WATER RESOURCES RESEARCH INSTITUTE

Who We Are

Established by the U.S. Congress in 1964, the Mississippi Water Resources Research Institute (MWRRI) is one of 54 institutes (one in each state, the District of Columbia, Guam, Puerto Rico, and the Virgin Islands) that form a network of research efforts coordinated to solve water problems of state, regional, or national significance. In 1983, the Mississippi Legislature formally designated the MWRRI as a state research institute. The Institute's state authorization charges it with assisting state agencies in the development of a state water management plan, maintaining a technology transfer program, and serving as a liaison between Mississippi and funding agencies.

Two Year Strategic Plan 2012-2013

Research

- Expand support for innovative agricultural programs such as REACH.
- Increase external funding opportunities for university faculty and research staff.

Education

- Utilize demonstration projects as service learning.
- Expand the number of funded graduate students.

Engagement/Outreach

- Offer workshops for technology transfer and revenue generation.
- Expand working relationship with local, state, and federal agencies.



The Institute acts as a clearinghouse for:



Phone: 662.325.8335
Fax: 662.325.1215
E-mail: gww@ra.msstate.edu
www.wrri.msstate.edu

Physical Address
190 Bost North
Suite 311
Miss State, MS 39762

Project: Research and Education to Advance Conservation and Habitat (REACH)

- The REACH program goal is to create a network of cooperative farms in Mississippi, with variable agricultural systems, conservation initiatives and ecosystem monitoring to illustrate the success of conservation practice implementation on landscape stewardship.
- Currently, REACH has enrolled 32 Mississippi farms in the program. They are located in 20 counties, and total over 100,000 acres.
- During FY 2013 the WRRRI committed \$50,000 in matching funds to help REACH leverage over \$300,000 in other funding. The funds were used to support one MSU graduate student, match the purchase of field monitoring equipment, and provide building materials for students to construct wooden structures to house field data collecting equipment. The student project was completed at Hinds Junior College.



Project: MDEQ/EPA 319 Rotten Bayou Project



- Rotten Bayou is a coastal watershed located in Hancock, Mississippi covering approximately 35 square miles. The bayou drains into the Bay St. Louis, which later drains into the Gulf of Mexico. This area is under pressure from population growth, urbanization, and agricultural practices such as cattle farming. The watershed has been identified by the Mississippi Department of Environmental Quality (MDEQ) as having impairments such as low dissolved oxygen, turbidity, and excessive nutrient loads.
- The WRRRI has a contract with MDEQ to assist the newly formed town of Diamondhead develop a stormwater ordinance that will help improve water quality in Rotten Bayou. The Institute committed \$5,000 in matching funds to help secure a \$98,000 grant that has implications for the entire Mississippi Gulf Coast metropolitan area.

Project: USGS 104b Annual Competitive Grants



Annually the WRRRI receives federal funds from the U.S Geological Survey to support water related research. Each year we use approximately \$60,000 in matching funds to secure \$120,000 in external funds and support. During FY 12 and FY 13, three projects were funded at MSU and three at UM.



WRRI Success Profile: Toyota Corporation

Researchers: The College of Agriculture and Life Science , Mississippi State University
The School of Engineering, University of Mississippi

Project: Water Harvesting and other Sustainable Design Practices
Toyota Motor Manufacturing, Mississippi (TMMS), Blue Springs, MS.



- Availability of adequate water supplies are a critical factor impacting site selection for major industries. Such issues can hinder the location of future mega-site facilities such as a Nissan and a Toyota.
- The Toyota Motor Manufacturing, Mississippi (TMMS), located at Blue Springs, MS, requires significant amounts of water supplies for use in the automobile production process. If fully operational, the Toyota plant could require up to 2,000,000 gals of water per day to meet production demands. Current water needs are supplied by surface sources, since groundwater reserves are inadequate.



- The MWRI and researchers at the University of Mississippi and Mississippi State University are exploring alternative sustainable design approaches, including water harvesting and storage. Thousands of gallons of rainwater could be captured and stored in surface or sub-surface containment facilities for later use in the production process or for site needs. By capturing this naturally occurring resource TMMS can reduce their impact on regional water supplies that can later be used by support industries that will be developing around the site.
- TMMS has indicated that they want to use this plant as the model for all future sustainable plants located in the United States. The MWRI is excited to be able to contribute to the economic growth of the state and the nation.



Locations of WRR Supported Projects 2012-13



**REACH Supported
Research Sites**



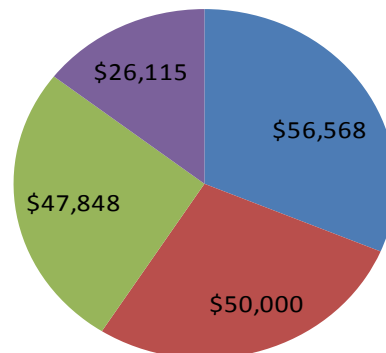
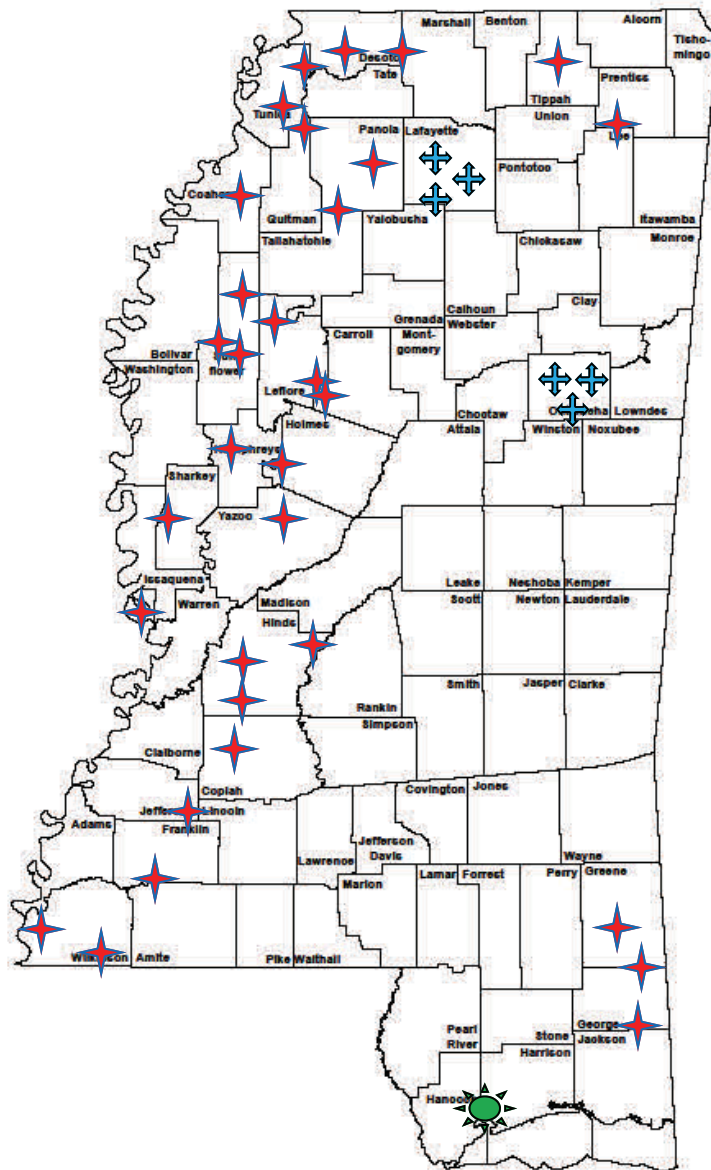
**MDEQ/EPA 319
Project**



USGS 104b Projects

Project Descriptions

- The WRRRI receives funding support from both the Department of the Interior, through the USGS, and the State of Mississippi to support water related research. Currents projects include:
 - Six on-going USGS funded University research projects, three located at the University of Mississippi, and three at Mississippi State University. These require administrative and project match.
 - REACH, a network of cooperative farms with a focus on innovative farming practices. Currently, 32 MS farms are enrolled.
 - A NRCS/EPA/MDEQ project focused on water quality in Rotten Bayou. Funds are also being used to leverage equipment purchases for irrigation research in the MS Delta.



■ 104b Project Match

■ REACH

■ Administrative Match

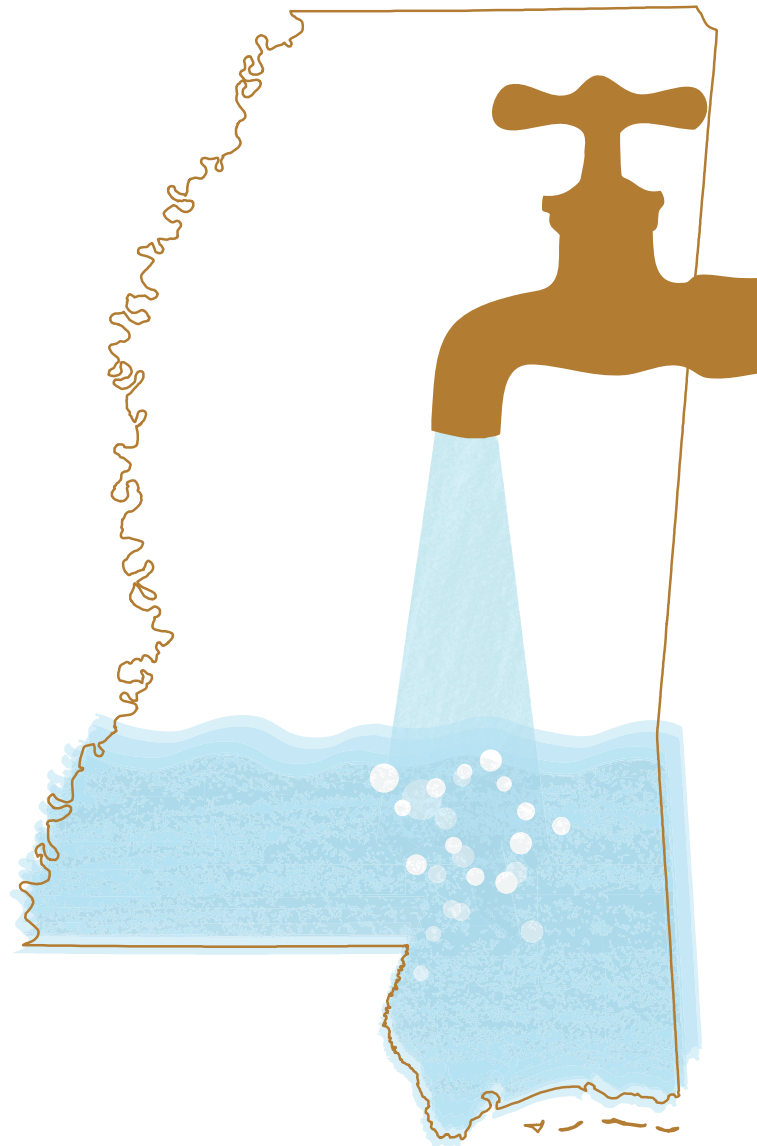
■ Rotten Bayou/Delta

2012

Mississippi Water Resources Conference

Hilton Jackson

Jackson , MS



EXHIBITORS:

Florence & Hutcheson Inc.
G.E.C. Inc.
Mississippi Department of
Environmental Quality
Pickering Firm Inc.
U.S. Geological Survey

SPONSORS:

Delta Council
Florence & Hutcheson Inc.
G.E.C. Inc.
Michael Hatcher & Associates Inc.
Mississippi Department of Environmental Quality
MSU Department of Geosciences

MSU Department of Landscape Architecture
Mississippi Water Resources Association
Mississippi Water Resources Research Institute
U.S. Geological Survey
Weyerhaeuser Company
Yazoo-Mississippi Delta Levee Board

CONFERENCE ORGANIZERS:

Mississippi Water Resources Research Institute | Mississippi Department of Environmental Quality
Mississippi Water Resources Association | U.S. Geological Survey

7:30
a.m.

REGISTRATION AND CONTINENTAL BREAKFAST

8:00
a.m.

PLENARY SESSION

Wayne Wilkerson
Mississippi State University

Mickey Plunkett
U.S. Geological Survey

Gregory Bohach
Mississippi State University

Richard Harrell
*Mississippi Department of
Environmental Quality*



WAYNE WILKERSON

Wayne Wilkerson is Director of the Water Resources Research Institute and an Associate Professor in the Department of Landscape Architecture at Mississippi State University. He earned his master's degree in Landscape Architecture at Louisiana State University. Prior to his employment at Mississippi State, Wilkerson worked for the LSU AgCenter and Gulf Engineers and Consultants. Wilkerson has been very active in water-related research throughout his tenure at Mississippi State.



MICKEY PLUNKETT

Mickey Plunkett is the Director at U.S. Geological Survey, Mississippi Water Science Center in Jackson. He earned a bachelor's degree from Mississippi State University in Civil Engineering. He is licensed as a Registered Professional Engineer in the state of Mississippi. Plunkett began with the USGS as a cooperative education student and has held numerous positions including civil engineer within the bridge-site studies unit, Chief of the Surface-water Records Unit, and Chief of the Hydrologic Data Section prior to being selected as the Center Director in 2001.



GREGORY BOHACH

Greg Bohach is Vice President for the Division of Agriculture, Forestry and Veterinary Medicine at Mississippi State University. He earned a bachelor's degree from the University of Pittsburgh and master's and doctoral degrees from West Virginia University. Prior to joining Mississippi State, he served as associate dean of the College of Agricultural and Life Sciences and director of the Idaho Agricultural Experiment Station. As Vice President, Bohach provides visionary leadership for the division's research, teaching, extension and service activities.



RICHARD HARRELL

Richard Harrell is Director in the Mississippi Department of Environmental Quality's Office of Pollution Control. He earned a bachelor's degree from Mississippi State University in Chemical Engineering and a master's degree in Environmental Engineering from the University of Mississippi. He is a Registered Professional Engineer in the state of Mississippi. A native of Brandon, Harrell has worked for the Mississippi DEQ for 18 years, serving as an engineer and branch chief before assuming the duties of director last year.

9:15
a.m.

BREAK | POSTER JUDGING AND EXHIBITS

Eduardo Arias-Araujo
Mississippi State University

Soil Moisture and Watershed Assessment to Predict Wildfire Occurrences in the Southeast of United States

Hamid Borazjani
Mississippi State University

Efficacy of Manufactured Wood Shavings to Mitigate Marsh Land Impacts Associated With Deep Water Oil Spills

David Burt
US Geological Survey

Assessment of Improved Sensors to Monitor Water Used for Irrigation in the Mississippi Delta

James Cizdziel
University of Mississippi

Measuring Fallout Plutonium and Lead Isotopes in Sediment Using ICPMS for Dating Purposes

Susan Godwin
Auburn University

Resource Management in the Lost World of the Little Cahaba River Glades

Daniel Goetz
Mississippi State University

Identifying Fish Guilds Relative to Water Quality and Depth in Oxbow Lakes of the Mississippi Alluvial Valley

Vaibhav V. Joshi
Mississippi State University

Comparison of Indigenous and Selected Pentachlorophenol (PCP) Degrading Bacterial Consortia for Remediation of PCP Contaminated Groundwater

Min Lee
Mississippi State University

Formaldehyde Released in Leachate from Medium Density Fiberboard (MDF) Buried in a Simulated Landfill

Michael A. Manning
US Geological Survey

Preliminary Results from a New Ground-Water Network in Northeastern Mississippi

Brad Maurer
The Nature Conservancy

The Buttahatchie River Stabilization Project

Giusy Pappalardo
University of Catania

Laymen, Experts, NGOs, and Institutions in Watershed Management

9:15
a.m.

POSTER SESSION

Beth Poganski

Mississippi State University

Assessment of the Ecological Value of Low-Grade Weirs in Agricultural Drainage Ditches

John J. Ramirez-Avila

Mississippi State University

Assessing and Modeling Sediment Loads from Stream Corridor Erosion along the Town Creek in Mississippi

John J. Read

USDA ARS

Rainfall Simulation to Evaluate Nutrient Loss from Marietta Soil Amended with Poultry and Cattle Manure

Jing Sheng

USDA ARS

Effects of Immobilizing Agents on Surface Runoff Water Quality from Bermudagrass Sod Fertilized with Broiler Litter

Natalie Sigsby

Mississippi State University

Sedimentation Processes in Perdido Bay

Jonathan Sloan

Mississippi State University

Hydrologic Regimes of Bottomland Hardwood Forests in the Mississippi Alluvial Valley and Gulf Coastal Plain and the Impact on Red Oak Acorn Production

Jennifer Sloan-Ziegler

Mississippi State University

Sediment and Mercury Fate and Path Modeling in Weeks Bay, Alabama

Shane Stocks

US Geological Survey

Monitoring Success of Mississippi's Delta Nutrient Reduction Strategies—Steele Bayou

Long Zhou

Auburn University

Proposal of the Total Human Ecosystem on Blakeley Island, Mobile, AL

9:30
a.m.

CONCURRENT TECHNICAL PRESENTATIONS

Session #1 - Best Management Practices #1

Diplomat I

Moderator: Larry Oldham, Mississippi State University

Samuel C. Pierce (*Mississippi State University*) Field-Scale Monitoring of Agricultural Ditches as Conduits of Nitrogen, Phosphorus, and Suspended Sediment in Response to Storm Events and Low-Input Drainage Management: A Case-study of the Tchula Lake Farm

Corrin Flora (*Mississippi State University*) Nutrient and Suspended Sediment Mitigation Through the Use of a Vegetated Ditch System Fitted with Consecutive Low-Grade Weirs

J.J. Ramirez-Avila (*Mississippi State University*) Runoff Quality Effects of Simulated Conservation Practice Scenarios in a Mississippi Delta's Watershed

Larry Oldham (*Mississippi State University*) The Mississippi Nutrient Management Manual: Simplifying Availability of Maintenance-Based Fertilizer Recommendations and Nutrient Best Management Practices

Session #2 - Delta Water Assessment

Diplomat II

Moderator: Charlotte Bryant Bird, Mississippi Department of Environmental Quality

Charlotte Bryant Byrd (*Mississippi Department of Environmental Quality*) The Great Flood of 2011 and its Influence on the Mississippi River Valley Alluvial Aquifer: Did the River Recharge the Aquifer or What?

Paul Parrish (*Mississippi Department of Environmental Quality*) Snapshot Through Time of "The Hole" in the MRVA of the Central Delta (Sunflower and Leflore County)

Priyantha Jayakody (*Mississippi State University*) Develop Hydrological Relationships using a Modeling Approach in Mississippi Delta

Jeannie R.B. Barlow (*U.S. Geological Survey*) Nitrogen dynamics within the Big Sunflower River Basin in northwestern Mississippi

9:30
a.m.

CONCURRENT TECHNICAL PRESENTATIONS

Session #3 - Flood Assessment and Management

Amphitheater I

*Moderator: Tom Bryant,
Pickering Firm Inc.*

Amanda Roberts (*National Weather Service*) Flooding Concerns on the Lower Pearl River Near Walkiah Bluff, MS

Heather Welch (*U.S. Geological Survey*) Movement of Agricultural Chemicals and Sediment Through the Lower Mississippi River Basin During the 2011 Flood, April through July

Marcia S. Woods (*U.S. Geological Survey*) Water-quality of the Yazoo River During the 2011 Mississippi River Flood

John Storm (*U.S. Geological Survey*) Flood Inundation Mapping for the Leaf River at the City of Hattiesburg, MS

Session #4 - Wetlands

Amphitheater II

*Moderator: Mickey
Plunkett, U.S. Geological
Survey*

Amy B. Alford (*Mississippi State University*) Nutrient Characteristics of Moist-Soil Wetlands in Agriculture Landscapes

Marc A. Foster (*Cypress Environmental Services*) Management of Coastal Ecosystem Restoration Sites under Increased Climatic Extremes: Effects of Hurricane Katrina on Wetlands Restoration Projects in Coastal Mississippi

K. Van Wilson (*U.S. Geological Survey*) Sea Level Rise Visualization and Measurements of Subsidence and Accretion Rates for the Alabama, Mississippi, and Florida Coastlines

William B. Roth (*Anchor QEA, LLC*) Beneficial Use at Deer Island: A Decade of Design and Implementation

11:00
a.m.

POSTER JUDGING AND EXHIBITS

11:30
a.m.

LUNCH AND KEYNOTE ADDRESS

Eric J. Evenson *Coordinator, National Water Census, U.S. Geological Survey*



ERIC J. EVENSON

Eric J. Evenson has been the USGS Coordinator for the National Water Census since 2008. The USGS Water Census is one of the six major themes in the Survey's Science Plan, investigating the various aspects of water availability and use. He started with USGS in 1992. Prior to his current position, he served for six years as the Regional Program Officer of the USGS, Northeastern Region Water Programs and ten years in the New Jersey District Office as the Associate District Chief and the District Chief. A native of Nebraska, he earned a bachelor's in Zoology and a master's in Ecology from the University of Nebraska.

1:00
p.m.

CONCURRENT TECHNICAL PRESENTATIONS

Session #5 - Watershed Management #1

Diplomat I

*Moderator: Richard
Rebich, U.S. Geological
Survey*

Giusy Pappalardo *(University of Catania)* Laymen, Experts, NGOs, and Institutions in Watershed Management

Susan Godwin *(Auburn University)* Resource Management in the Lost World of the Little Cahaba River Glades

Ron Killebrew *(Mississippi Department of Environmental Quality)* Management Challenges for Deer Creek in the Mississippi Delta

Richard A. Rebich *(U.S. Geological Survey)* Results of Regional SPARROW Models for Selected Watershed in Mississippi

Session #6 - Non- Point Source Assessment

Diplomat II

*Moderator: Jeff Hatten,
Mississippi State University*

Brad Mauer *(The Nature Conservancy)* The Buttahatchie River Stabilization Project

Jeff Hatten *(Mississippi State University)* Sources and Yield of Particulate Organic Carbon and Nitrogen In Managed Headwaters of Mississippi

Caroline Andrews *(Mississippi State University)* Predicting Nitrogen and Phosphorus Concentrations using Chlorophyll-a Fluorescence and Turbidity

Cristiane Q. Surbeck *(University of Mississippi)* Water Quality in Sardis Lake: A Multi-Variate Statistical Method for Analysis of Temporal and Spatial Trends

1:00
p.m.

CONCURRENT TECHNICAL PRESENTATIONS

Session #7 - Modeling

Amphitheater I

*Moderator: Lynn Prewitt,
Mississippi State University*

David Bassi (*Mississippi State University*) Analyzing the Hydraulics of a Biofiltration Swale Using HEC-RAS

Jennifer Sloan-Ziegler (*Mississippi State University*) Sediment and Mercury Fate and Path Modeling in Weeks Bay, Alabama

Surendra Raj Pathak (*Mississippi State University*) Calculation of Water Surface Elevation Using HECRAS 4.1.0 for Fixing Tailwater Elevation for Powerhouse Site in Planned 37 MW Kabeli "A" Hydroelectric Project, Nepal

Sarah Duffy (*Mississippi State University*) Assessing Water Balance Using a Hydrologic Model

Session #8 - Water Quality

Amphitheater II

*Moderator: Matt
Römkens, USDA
Agricultural Research
Service*

R.H. Coupe (*U.S. Geological Survey*) The Fate and Transport of Glyphosate and AMPA into Surface Waters of Agricultural Watersheds

Claire Rose (*U.S. Geological Survey*) A Holistic Assessment of the Occurrence of Metolachlor and 2 of its Degradates Across Various Environmental Compartments in 7 Environmental Settings

Cory M. Shoemaker (*Mississippi State University*) Assessing a Novel Method for Verifying Automated Oxidation-Reduction Potential Data Loggers: Laboratory and Field Tests

Matthew B. Hicks (*U.S. Geological Survey*) Using Dissolved Oxygen Dynamics to Derive Nutrient Criteria: Tried, True, and Troublesome

2:30
p.m.

BREAK | POSTER JUDGING AND EXHIBITS

3:00
p.m.

CONCURRENT TECHNICAL PRESENTATIONS

Session #9 - Best Management Practices #2

Diplomat I

Moderator: Mary Love Tagert, Mississippi State University

Mary Love Tagert (*Mississippi State University*) Downstream Water Quality and Quantity Impacts of Water Storage Systems in a Mississippi Delta Watershed

Alex Littlejohn (*Mississippi State University*) Low-Grade Weirs: An Innovative Best Management Practice for nitrate-N Mitigation

Sandra Ortega-Achury (*Mississippi State University*) Evaluation and Validation of a Decision Support System for Selection and Placement of BMPs in the Mississippi Delta

Robert Kröger (*Mississippi State University*) Best Management Practices in the MS Delta: What Are We Learning?

Session #10 - Delta Water Conservation

Diplomat II

Moderator: Dean Pennington, Yazoo Mississippi Delta Joint Water Management District

Joseph H. Massey (*Mississippi State University*) Water-Conserving Irrigation Systems for Furrow & Flood Irrigated Crops in the Mississippi Delta

Robert G. Thornton (*Mississippi State University*) Modeling the Potential for Replacing Groundwater with Surface Water for Irrigation by Using On-Farm Storage Reservoirs in the Mississippi Delta

Shane Powers (*U.S. Geological Survey*) Technologies and Methods to Aid the Adoption of PHAUCET Irrigation in the Mississippi Delta

Brandon Rice (*University of Mississippi*) MIST: A Web-Based Irrigation Scheduling Tool for Mississippi Crop Production

3:00
p.m.

CONCURRENT TECHNICAL PRESENTATIONS

Session #11 - Sedimentation

Amphitheater I

*Moderator: Jami Nettles,
Weyerhaeuser Company*

Matt Römken (*USDA Agricultural Research Service*) The National Reservoir Sedimentation Data Base: Background and Purpose

Natalie Sigsby (*Mississippi State University*) Sedimentation Processes in Perdido Bay

James Cizdziel (*University of Mississippi*) Measuring Fallout Plutonium and Lead Isotopes in Sediment Using ICPMS for Dating Purposes

James Chambers (*University of Mississippi*) Using Acoustic Measurements as a Surrogate Technique for Measuring Sediment Transport

Session #12 - Storm Water

Amphitheater II

*Moderator: Warren
"Cory" Gallo, Mississippi
State University*

Clay Mangum (*Mississippi State University*) Sources and Yield of Dissolved Inorganic and Organic Constituents in Headwater Streams of the Upper Gulf Coastal Plain, Mississippi

Emily Overbey (*Mississippi State University*) Policy Approaches to Stormwater Facility Sizing and Sustainable Site Design

Warren Corrado Gallo (*Mississippi State University*) Adapting Portland's Stormwater Approach to Other U.S. Cities

Jesse English (*Mississippi State University*) Holitoblich: A Celebration of the North Mississippi Hills

5:00
p.m.

WELCOME RECEPTION

7:30
a.m.

REGISTRATION AND CONTINENTAL BREAKFAST | POSTER JUDGING AND EXHIBITS

8:00
a.m.

CONCURRENT TECHNICAL PRESENTATIONS

Session #13 - Watershed Management #2

Diplomat I

*Moderator: Jamie
Crawford, MDEQ*

Mike Daniels (*University of Arkansas*) The Arkansas Discovery Farms Program

Ethan Mower (*Mississippi State University*) Rule Curves in Flood Control Reservoirs: A Historical and Procedural Analysis

Elizabeth Usborne (*Mississippi State University*) Preliminary Sediment Accumulation and Phosphorus Retention Behind Low Grade Weirs in the Mississippi Delta

Matthew B. Hicks (*U.S. Geological Survey*) Monitoring Success of Mississippi's Delta Nutrient Reduction Strategies

Session #14 - Public Water Systems

Diplomat II

*Moderator: Jason
Barrett, Mississippi
State University*

Rebecca A. Werner (*University of Mississippi*) Financial Sustainability of Water Treatment and Distribution: Using a Public Private Partnership Toolkit to Evaluate Project Costs

Jason Barrett (*Mississippi State University*) The Influence of the Mitchell Rate Structure on Community Drinking Water Consumption and Customer Fairness

Alan Barefield (*Mississippi State University*) An Analysis of Factors Influencing Capacity Development of Public Water Systems in Mississippi

Session #15 - Surface Water Assessment and Evaluation

Amphitheater I

*Moderator: Prem
Parajuli, Mississippi
State University*

Ying Ouyang (*USDA Forest Service*) An Approach for Low Flow Selection in Water Resource Management

Prem B. Parajuli (*Mississippi State University*) Sediment and Nutrients Loadings from the Upper Pearl River Watershed

Alina Young (*Mississippi State University*) Evaluating a Vegetated Filter Strip in an Agricultural Field

Eduardo Arias-Araujo (*Mississippi State University*) Soil Moisture and Watershed Assessment to Predict Wildfire Occurrences in the Southeast of United States

9:30
a.m.

BREAK | POSTER JUDGING AND EXHIBITS

10:00
a.m.

PANEL SESSION

Trey Cooke

Delta F.A.R.M.

Larry Jarrett

Desoto County
Greenways

William McAnally

Northern Gulf
Institute

Cristiane Surbeck

University of
Mississippi

Coen Perrott

MDEQ Basin Team



TREY COOKE

Executive Director of Delta F.A.R.M. and Delta Wildlife. He earned a bachelor's degree from Delta State University and a master's degree in Biology from Sam Houston State University (Texas). A native of Leland, he spent summers working on a cotton, rice and soybean farm near Holly Ridge. Prior to his employment in the Delta conservation organizations, he worked with the U.S. Fish and Wildlife Service in Colorado.



LARRY JARRETT

Manager at Pine Ridge Marketing LLC, a full service commercial and industrial real estate firm serving Mississippi. Pine Ridge Marketing is actively involved in Green Infrastructure training in Mississippi on behalf of the MDEQ and US EPA. He has recently been contracted by Desoto County to develop a county Greenways program. Prior to his involvement with Pine Ridge, he worked with the Southern Forest Network, a regional non-profit forest-based conservation organization.



WILLIAM McANALLY

Professor of Civil and Environmental Engineering at Mississippi State University and co-director of the Northern Gulf Institute. He has worked for the U.S. Army Corps of Engineers and is a Registered Professional Engineer in the state of Mississippi. He is also a Fellow of the American Society of Civil Engineers. He earned a bachelor's degree from Auburn University, and master's and doctoral degrees in Coastal and Oceanographic Engineering from the University of Florida.



CRISTIANE SURBECK

Assistant Professor of Civil Engineering at the University of Mississippi. She earned her bachelor's degree from the University of Maryland and master's and doctoral degrees in Environmental Engineering from the University of California, Irvine. Prior to joining Ole Miss, she worked in the environmental consulting industry. Her areas of research include fate and transport of pollutants in surface waters, stormwater best management practices (BMPs), and soil and groundwater remediation.



COEN PERROTT

Basin Coordinator for the Pascagoula, Coastal Streams, and Lower Pearl River Basins, in the Surface Water Division, of the Office of Pollution Control, Mississippi Department of Environmental Quality. He earned a bachelor's degree from Mississippi State University. He has worked for MDEQ for 21 years, beginning in Field Services. He has worked in Permitting, Pollution Prevention, Small Business Assistance, Environmental Assistance, and Surface Water for the state agency.

11:30
a.m.

LUNCH AND AWARDS

Stephen Kirkpatrick, Kirkpatrick Wildlife Photography



STEPHEN KIRKPATRICK

Stephen Kirkpatrick has been chased by grizzly bears, attacked by alligators, and nibbled by piranha. In the process, he's captured some of the world's most beautiful and exciting nature and wildlife photography. Kirkpatrick has published more than 3,000 photographs in books and magazines. He has published 11 solo pictorial coffee table books. His latest, *Sanctuary*, is a tribute to the rare and endangered species and habitats of the Mississippi Coastal Plain.

1:00
p.m.

ADVISORY BOARD MEETING

Notes

Proceedings from this conference and past water resources conferences are available online at
www.wrri.msstate.edu



MISSISSIPPI STATE
UNIVERSITY[™]

USGS Summer Intern Program

None.

Student Support					
Category	Section 104 Base Grant	Section 104 NCGP Award	NIWR-USGS Internship	Supplemental Awards	Total
Undergraduate	9	0	0	0	9
Masters	5	0	0	0	5
Ph.D.	1	0	0	0	1
Post-Doc.	0	0	0	0	0
Total	15	0	0	0	15

Notable Awards and Achievements